PROGRESS IN SOIL AND WATER CONSERVATION RESEARCH

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USE OF THIS REPORT

These Quarterly Reports are prepared by scientists and engineers of the Soil and Water Conservation Research Division. They are reviewed for technical excellence and applicability to soil and water problems and edited by the Branch staffs and SCS-ARS Research Liaison Representatives.

This is not a publication and should not be referred to in literature citations. The report is distributed to U. S. Department of Agriculture personnel engaged in soil and water conservation and to directly cooperating professional agricultural workers who are in a position to analyze and interpret the preliminary results and tentative findings of experiments reported herein.

The Division will publish the results of experiments reported here as promptly as possible. Some of the results carried in these quarterly reports are simultaneously in the process of publication.

Personnel desiring to make public references to data or statements in this report should submit the proposed material to the Division for approval, indicating the intended use. The Division, but not the report, may be given as the source.

Questions about or discussions of the information in these reports may be addressed directly to the research workers whose names appear on the items, or to Branch Chiefs, or to the Division Director.

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The Soil and Water Conservation Research Division works in cooperation with State Agricultural Experiment Stations.

Assembled in the office of D. M. Whitt, ARS-SCS Liaison Officer.

Report for April-June 1959 Issued July 1959

NOTE

Beginning with this issue an effort is being made to more definitely relate research reports of the Division to the research needs of the Soil Conservation Service. Following each item in the report the specific need to which the item responds is indicated by code. The code consists of the numerical and alphabetical designation of headings in the most recent National Soil and Water Conservation Research Needs Report of SCS to ARS. For example, the item from Wisconsin by Orville E. Hays entitled, "Less erosion occurs from graded rows in stripcropping," is related to IV, Erosion control; B, Stripcropping; and 1, Strip width, grade, direction. This fact is indicated by the addition of (IV-B-1) at the end of the item.

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IRRIGATION

Idaho

"K" FACTORS FOR USE IN BLANEY-CRIDDLE FORMULA

Claude H. Pair, Boise.--Monthly "k" and Seasonal "K" factors for use in computing the consumptive use of water by a mixture of alfalfa and hard fescue grass under irrigation by the Blaney-Criddle formula have been determined. The factors were determined from the water use measurements made in the Black Canyon Irrigation Investigations near Caldwell, Idaho. Water use was calculated from the data obtained by standard procedures, i.e., sampling soil before and after irrigation. The soil samples were dried and percentage of moisture calculated by conventional methods.

The Monthly "k" factors are based on the use between soil sampling periods occurring during the month. The Seasonal "K" is based upon the total seasonal consumptive use calculations during the growing season which includes allowances for consumptive use during the irrigation period and rainfall between soil sampling periods.

The alfalfa and hard fescue grass mixture was seeded in the fall of 1953. It was harvested each year in June, July, and September.

The average Seasonal "K" coefficient of 0.70 compares with the "K" of 0.85 recommended for this area in the publication entitled, "Estimated Irrigation Water Requirements for Idaho." (II-A-1)

Monthly "k" and Seasonal "K" factors for use in the Blaney-Criddle formula to compute the consumptive use of water by an alfalfa and hard fescue grass mixture, Black Canyon Irrigation Investigations, Boise, Idaho

Year	Monthly "k" factor						Yearly "K" factor
	April	May	June	July	August	September	
1954 First year seeding..	0.57	0.77	0.67	0.78	0.84	0.52	0.70
1955 Second year crop....	.58	.84	.80	.68	.71	.62	.77
1956 Third year crop.....	.57	.74	.63	.81	.62	.64	.62
Average for 3 years of crop............	.57	.78	.70	.76	.72	.59	.70

INTAKE EQUATION COMPUTED FOR ALFALFA AND ROW CROPS

Stephen J. Mech, Prosser.--The average seasonal water intake rate for fields in different crops grown in central Washington can be divided into two groups--alfalfa (except very young stand) and row crops. On the average, established alfalfa required about 12 hours of irrigation to add 5 inches of water to the soil, while row crops required approximately 24 hours to add the same amount.

Experiments leading to these conclusions were conducted with crops in a rotation on Sagemoor fine sandy loam at the Irrigation Experiment Station, Prosser, Washington. The tests included two furrow grades, three soil moisture ranges, and three irrigation stream sizes. The average accumulative intake and the intake rate curves are presented in figures 1 and 2 respectively. The equations for these curves are presented in the table. The time required for a 5-inch irrigation provides a quick comparison of the intake rate during the different crop years. The value of "b" in the general intake equation $I = at^b$ varied from -0.08 to -0.14 for alfalfa, and from -0.14 to -0.27 for row crops indicating that the percent of decrease in intake rate with time was less on alfalfa than on row crops.

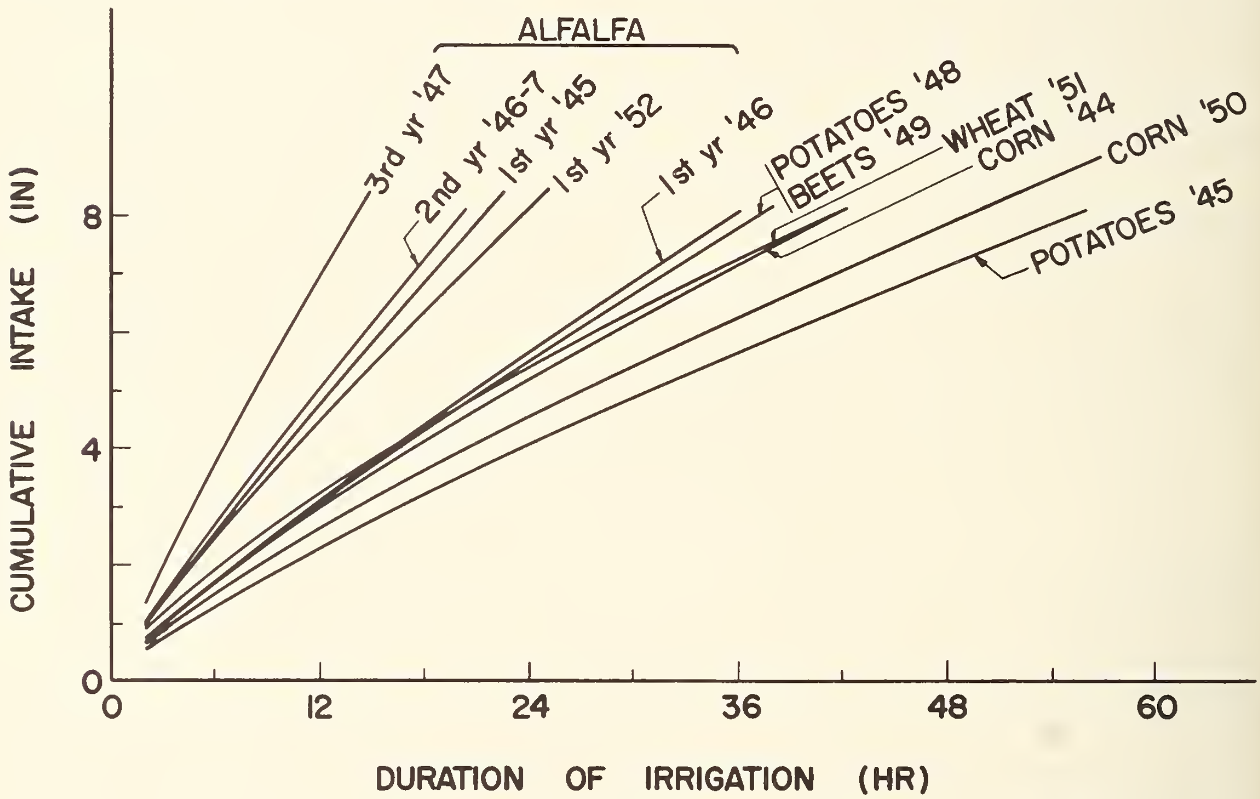


Fig. 1 CUMULATIVE INTAKE CURVES FOR CROPS IN A ROTATION. BEETS REDUCED TO 36-INCH SPACING.

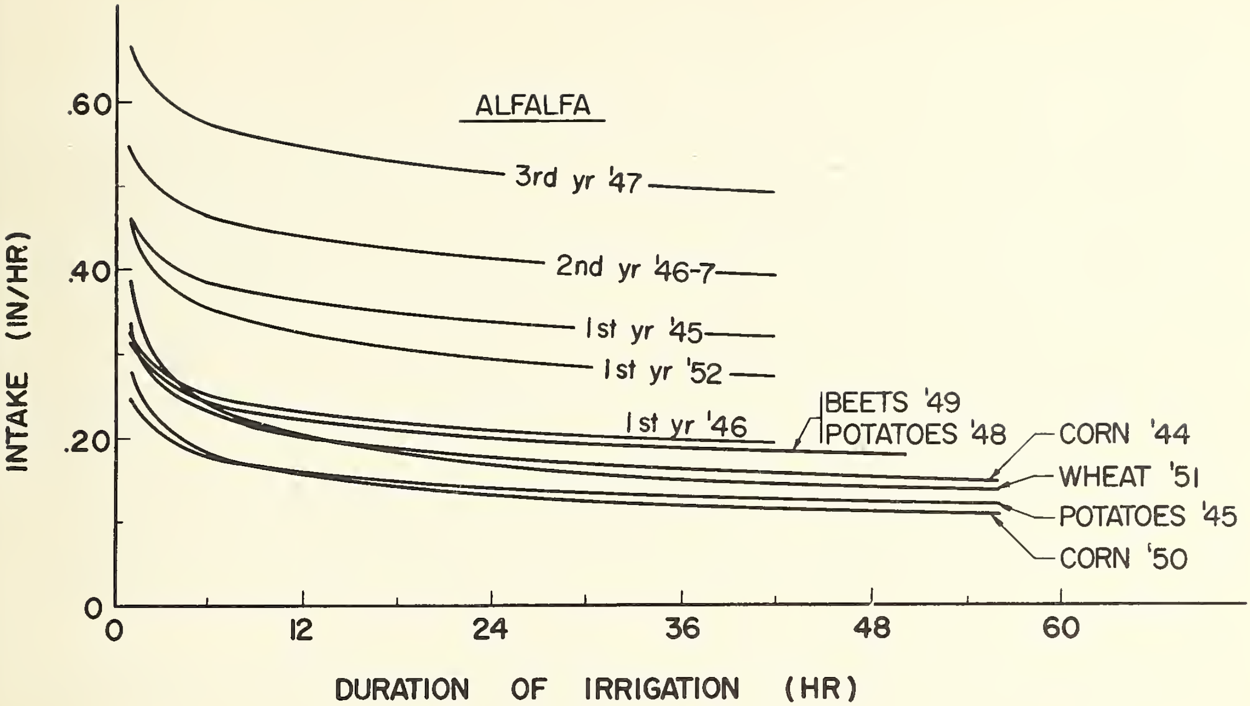


Fig. 2 SEASONAL INTAKE RATE CURVES FOR CROPS IN A ROTATION. BEETS REDUCED TO 36-INCH SPACING.

The 1946 alfalfa was seeded on September 7 of the previous year, and because of a very young stand, the intake rate was similar to that on row crops. The 1945 alfalfa was seeded on wheat in March 1944. The 1952 alfalfa was seeded in wheat stubble on August 9, 1951. (II-A-3)

Equation for intake curves shown in figures 1 and 2 based on 36-inch furrow spacings and time required for a 5-inch irrigation, Prosser, Wash.

Crop	Intake equations: Rate	Intake equations: Cumulative	Time required for 5-inch irrigation
	Inches/hour	*Inches*	*Hours*
Alfalfa, 1947, 3rd cut. yr......	$0.66\ t^{-0.08}$	$0.72\ t^{0.92}$	8.2
Alfalfa, 1946-47, 2nd cut. yr......	$.54\ t^{-0.09}$	$.60\ t^{0.91}$	10.6
Alfalfa, 1945, 1st cut. yr......	$.46\ t^{-0.10}$	$.51\ t^{0.90}$	12.6
Alfalfa, 1952, 1st cut. yr......	$.46\ t^{-0.14}$	$.53\ t^{0.86}$	13.6
Alfalfa, 1946, 1st cut. yr......	$.32\ t^{-0.14}$	$.38\ t^{0.86}$	19.9
Sugar beets, 1949..................	$.31\ t^{-0.14}$	$.36\ t^{0.86}$	21.4
Potatoes, 1948..................	$.32\ t^{-0.15}$	$.37\ t^{0.85}$	21.4
Wheat, 1951..................	$.38\ t^{-0.27}$	$.52\ t^{0.73}$	22.2
Corn, 1944..................	$.33\ t^{-0.21}$	$.42\ t^{0.79}$	23.0
Corn, 1950..................	$.28\ t^{-0.24}$	$.36\ t^{0.76}$	32.0
Potatoes, 1945..................	$.25\ t^{-0.19}$	$.30\ t^{0.81}$	32.0

VAPOR PRESSURE OF WATER IN SOIL CAN NOW BE MEASURED

L. A. Richards and Gen Ogata, Riverside.--Force fields associated with solute particles in the soil solution and with the surface of the solid phase of the soil both decrease the activity of soil water and make it less available to plants. Both of these force effects also decrease the vapor pressure of water in soil, and this property of water in soil can be measured by a method recently developed at the U. S. Salinity Laboratory. The vapor-pressure measuring procedure is for soil samples under carefully controlled laboratory conditions, but there is every reason to expect that the instrumental requirements will eventually be considerably simplified.

Soil-moisture tension, which is also referred to as "soil suction," has been measurable over a limited range with tensiometers. The osmotic pressure of the soil solution must be added to soil suction in order to obtain what has been called total stress or total suction of the soil water. When measured by the vapor-pressure procedure, the total suction of the water in a sample of soil may be defined as being numerically equal to the osmotic pressure of a standard salt solution having the same vapor pressure as the water in the soil sample at the same pressure and temperature. The data shown in the accompanying figure indicate the application of this new measuring method under saline conditions.

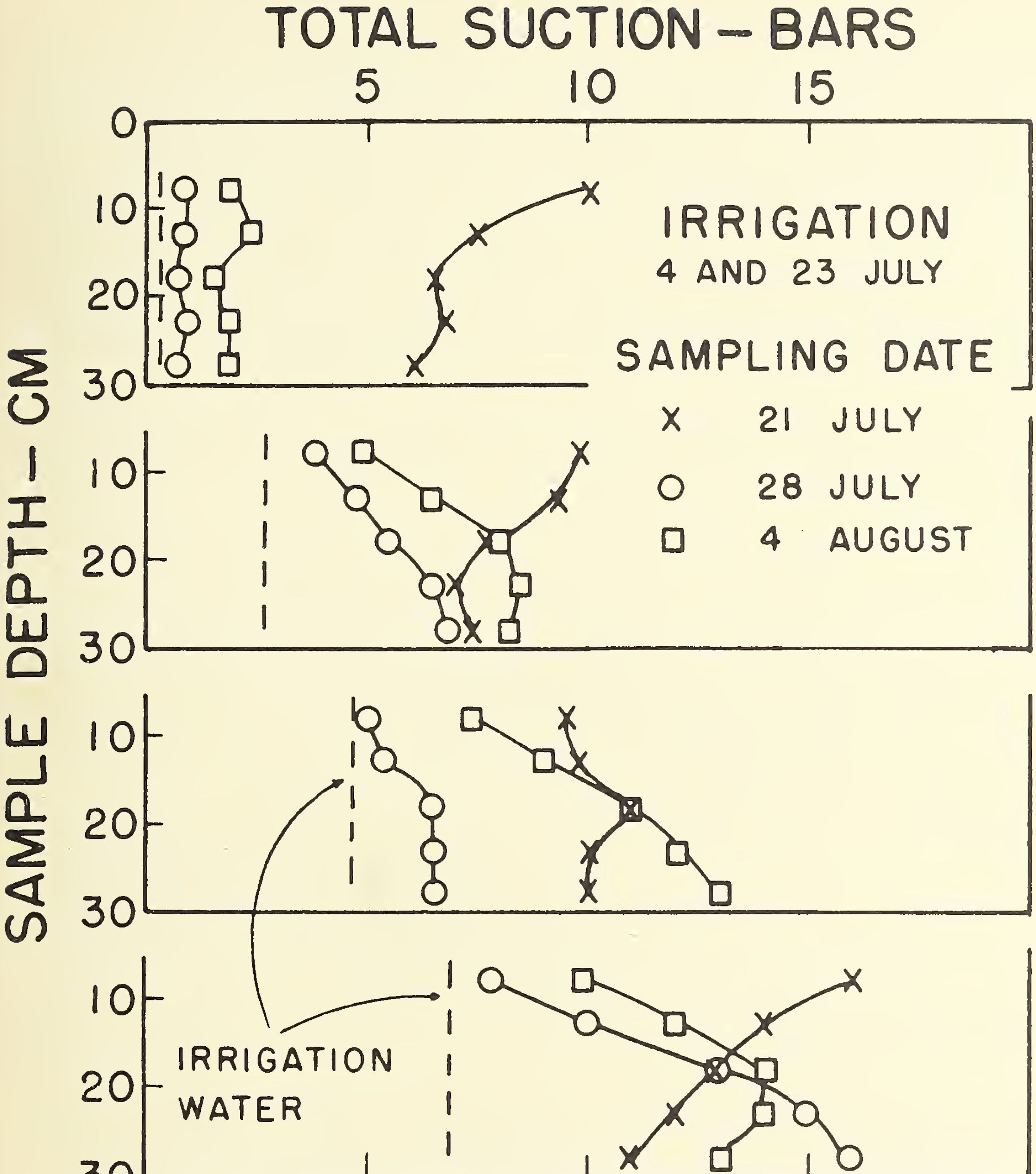
The plant research program at the Laboratory involves four field plots of cotton using, respectively, 0, 4,000, 8,000, and 12,000 p.p.m. of salt added to the Riverside irrigation water. On the days indicated, a single vertical set of soil samples was taken midway between plants in a row in each of the four plots.

The osmotic-pressure values of the irrigation waters are indicated by the dashed vertical lines in the figures and represent the lower limits of the total suction in the plots. These limits can be approached by leaching the soil with the irrigation water. The first sampling on July 21 was 17 days after irrigation and mostly gave higher total suction values near the surface, reflecting higher root activity there for the young plants.

At the second sampling on July 28, five days after irrigation, the soil was wet. Consequently, the soil suction was low, and the total suction values reported in the figure were due mainly to the osmotic pressure of the soil solution. The curves show salt-leaching by the flood irrigation. The 15-cm. depth of irrigation water that was applied in the level basins moved salt from the soil surface to the lower part of the sampling interval which was 30 cm. deep. Only at the soil surface was the leaching adequate to bring the total suction back nearly to the value of the osmotic pressure of the irrigation water.

The increases in suction in the time-interval from July 28 to August 4 were caused by extraction of water from the soil by the roots. The decrease in suction in this time-interval, indicated in the data at the bottom of the figures, is understandable when it is recalled that the points represent measurements of single samples in different profiles. In this plot having highest salinity, it is notable that, at the lower depths, because of the downward displacement of salt by the irrigation water, the data indicate that the total suction remained higher than it was before the irrigation.

The vapor-pressure method can be used for measuring the binding energy of water in soil under wet, dry, or saline conditions and will help to clarify the relation of crop response to soil-moisture status. (II-A-6)



Total suction profiles on different days in four cotton plots using irrigation water of different solute suction.

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Nevada

BENTONITE DISPERSION METHOD STUDIED FOR SEALING CANALS

M. B. Rollins, Reno.--Laboratory studies are being conducted on the physical and chemical properties of bentonites to clarify the process or processes involved in sealing irrigation canals. The dispersion method of sealing is based upon the principle of seepage transporting dispersed bentonite into the voids of a porous canal profile, thereby reducing seepage loss.

Bentonites from most of the western states will be studied for dispersion qualities, colloidal yield, swelling properties, viscosity, and gelation, plus related chemical and mineralogical properties. The properties that indicate possibilities of influencing bentonite penetration and retention in a canal profile will be tested on laboratory models of sand columns.

The results obtained from the study of bentonite properties and their effects upon extent of seal will be used to develop a reliable procedure to obtain an effective, stable seal under field conditions. (II-D-2)

Utah

FILM LININGS FOR SEEPAGE CONTROL EFFECTIVE AFTER FIVE YEARS

C. W. Lauritzen, Logan.--Nearly 5 years have passed since some plastic film linings were installed in test reservoirs. Linings tested included PVC (polyvinyl chloride) and PE (polyethelene). The linings have given excellent seepage control during this period. Seepage measured as shown in the table has been small. It has not increased with time except in the case of the exposed liners.

Seepage losses in film-lined reservoir at River Laboratory, Logan, Utah

Test	Lining*	Average daily drop in water surface			
		1955	1956	1957	1958
		Feet	*Feet*	*Feet*	*Feet*
1	PVC - 8 mil olive, buried.........	0.002	0.003	0.006	0.007
2	PVC - 8 mil olive, exposed........	.006	.015	.008	---
3	PVC - 8 mil black, exposed........	---	---	---	.009
4	PVC - 4 mil blue, exposed.........	.0001	.017	.010	.003
5	PVC - 2 mil clear, buried.........	---	---	.047	.033
6	PE - 8 mil black, buried.........	.004	.012	.024	.004
7	PE - 8 mil black, exposed........	.006	.007	.009	.017
8	PE - 4 mil black, buried.........	.015	.012	.006	.014
9	PE - 4 mil black, exposed........	.07	---	---	---

*Linings in test No. 2 were removed in 1957 because of severe deterioration above water surface elevation. Test No. 3 began in 1958. Linings in test No. 4 were removed in 1958 because of severe deterioration above water surface elevation. Test No. 5 began in 1957. Linings in test No. 9 were removed in 1955 because of holes and breaks in film lining; seepage still low compared to unlined reservoirs.

The increase in seepage for exposed liners resulted from mechanical damage occuring during installation and the subsequent period of use. Film liners less than 8 mils in thickness showed the greatest damage. Exposed vinyl liners were also subject to hardening and cracking above water level and in the area of water level fluctuation. These liners had to be removed after 2 or 3 years because of this condition.

The thinner exposed linings developed many small holes and a number of larger breaks and tears before they were removed. Even so, they continued to be more than 95 percent effective in controlling seepage. This seems to indicate that a limited amount of damage to linings during installation and while in use will not destroy their general effectiveness, particularly when installed on subgrades not subject to piping.

Although measurements have not been made, the linings installed in a number of farm and ranch reservoirs appear to be giving good seepage control. (II-D-2)

DRAINAGE

Nevada

SOIL GROUPINGS ARE MADE FOR DRAINAGE AND ECONOMIC STUDIES

Victor I. Myers, Russell D. Lloyd, and L. N. Langan, Reno.--Soil groupings for drainage studies have been made for the Lahontan Irrigation District of Nevada to serve as a basis for detailed technical and economic studies.

The most important consideration in grouping the soils is the manner in which they were formed. For example, the soils of the Newlands Project fall into two main categories: (1) those formed under poorly drained conditions which have profile differentiations; and (2) those formed under well-drained conditions which have little or no profile differentiation. The specific drainage considerations that affect the grouping of soils are as follows:

1. Fluctuation of the water table.
2. Stratification within the soil profile.
3. Water-holding capacities related to soil series.
4. Effects of soils on irrigation practices.
5. The influence of soil texture and soil profiles on canal seepage.

From an economic standpoint, the most important characteristic is the inherent productivity of the soil.

In the Lahontan District, two or three farms were selected as being representative of each drainage group. The following engineering, soils, and economics data are being collected from each of the sample farms:

1. Magnitude and extent of water table fluctuations from piezometer installations.
2. Soil permeabilities.
3. Soil moisture-holding capacities.
4. Irrigation efficiencies from field tests.
5. Alkali and salinity.
6. Irrigation practices, both present and recommended.
7. Magnitude of ditch seepage.
8. Recommendations for proper drainage methods where needed.
9. Costs of revising irrigation systems for improved irrigation and drainage.
10. Costs of installing recommended drainage improvements.
11. Effects of recommended drainage and irrigation practices on crop yields.
12. Economic effects on farm production and income.

The following project investigations are being conducted in addition to the detailed studies on individual sample farms:

1. Irrigation and drainage water quality is being determined.
2. Canal seepage measurements are being made to correlate seepage with the drainage groupings.
3. Laboratory and field investigations are being conducted to investigate the use of bentonite in sealing canals.
4. The efficiency of some existing drains is being determined and will be related to drainage groups.
5. Methods of stabilizing water tables are being investigated.
6. Studies are being made of the economic implications of project-wide drainage and related improvements.

Ultimately, drainage guides will be formulated on the basis of the detailed studies and will include recommendations for handling irrigation and drainage problems on the soils of each drainage group. (II-B-3)

Minnesota

EFFECT OF LENGTH AND DEGREE OF SLOPE ON LAND FORMING STUDIED

L. F. Hermsmeier, Morris.--The cost of land forming was increased 50 percent when length of slope was doubled and slope increased 0.1 percent on plots in the Red River Valley. The cost was increased 250 percent when length of slope was doubled and slope increased 0.3 percent. No significant difference was found in soil moisture or yield of sugar beets during the first year between 0.2 percent and 0.5 percent grade and between 320 feet and 640 feet length of slope.

The first test plots were constructed in Wilkin County, Minnesota, in the summer and fall of 1957. Soils were Fargo silty clay loam and silty clay, and the A horizon ranged in depth from 6 to 12 inches. Natural overall slope ranged from 0.11 percent to 0.36 percent, and there were numerous small depressions up to 1 foot deep. Half of the plots have a cross ditch at the mid-point.

The amount of earth moved, tractor time and costs per acre are shown in table 1.

TABLE 1.--Amount of earth moved, tractor time and costs per acre on the Ted Peet farm, Wilkin County, Minn., 1957

Slope	Length	Cut	Fill	Tractor time			
				Scraper	Leveler	Total	Cost
Percent	*Feet*	*Cu. yds.*	*Cu. yds.*	*Hours*	*Hours*	*Hours*	*Dollars*
0.20	320	191	77	3.1	2.1	5.2	52
	640	117	53	2.3	3.2	5.5	55
.50	320	206	113	5.0	2.0	7.0	70
	640	154	130	7.7	1.8	9.7	97

A second set of test plots was constructed in Wilkin County, Minnesota, during the summer of 1958. The test site is almost flat with a maximum difference in elevation of about 2 feet and no general grade. Soils are of Rocksbury, Kittson, Grimstad association. Half of the plots have a ditch at the mid-point. The test site will be planted to soybeans in 1959.

In table 2 are shown the amount of earth moved, tractor time and cost per acre. (V-H-2)

TABLE 2.--Amount of earth moved, tractor time and costs per acre on the Martin Gran farm, Wilkin County, Minn., 1958

Slope	Length	Cut	Fill	Tractor time			
				Scraper	Leveler	Total	Cost
Percent		*Cu. yds.*	*Cu. yds.*	*Hours*	*Hours*	*Hours*	*Dollars*
0.1	350	595	210	1.41	0.84	2.25	22.50
	700	508	220	2.42	0.66	3.08	30.80
0.2	350	1,004	389	1.33	0.84	2.17	21.70
	700	1,418	951	5.62	1.04	6.66	66.60
0.3	350	1,138	637	2.20	0.77	2.97	29.70
	700	1,261	1,058	6.31	1.14	7.45	74.50

EROSION AND RUNOFF CONTROL

Texas

RUNOFF MEASURED ON TERRACED HARDLANDS OF TEXAS HIGH PLAINS

Victor L. Hauser and Ronald R. Allen, Bushland.--Concrete type "H" water measuring flumes have been installed to measure runoff on a field scale at the USDA Southwestern Great Plains Field Station, Bushland, Texas. The soil is Pullman silty clay loam with a 1.8 percent slope between terraces. The terraces have a uniform grade of 0.1 percent and range in length from 1,650 feet to 2,000 feet. There are no potholes or ponds of any consequence in the terrace channels. Field sizes range from 5.10 to 8.10 acres.

Runoff is measured from three separate fields. The cropping sequence is wheat-sorghum-fallow with one field in each phase of the sequence at all times. All tillage is performed on the contour and stubble-mulch tillage is used to maintain a maximum of cover on the soil.

The flumes were finished early enough to measure all runoff that occurred in 1958. Results of the first year of record are shown in the accompanying table.

The wheat crop dried the soil almost to the wilting point before the runoff-producing rains occurred, but the fallow and sorghum fields were near field capacity in the top 2 feet of soil by the end of May. There was very little cover on the fallow and sorghum field. Residue from a 21.7 bushels per acre wheat crop was present on the wheat field.

Total precipitation for the 1958 calendar year was 21.69 inches which is 3.78 inches above the 19-year average. May, June, and August had below normal precipitation with a total deficit of 3.07 inches. July, however, had a total of 5.41 inches more precipitation than normal. Two major stormy periods occurred in July--July 5 and 6 with 3.33

inches of precipitation, and July 16 through 27 with 4.31 inches. During the storm period July 16 through 27 only 4 days out of the total 12-day period had less than 0.06 inch of rain; therefore, the soil surface never became dry to any appreciable depth.

Runoff from the land planted in grain sorghum was considerably higher than for fallow land on May 25 and July 5 and 6. It is possible that the difference on May 25 and July 5 could be attributed to a drier soil condition on the fallow land following sorghum harvest in the fall of 1957 compared to fallow in the fall of 1957 for the sorghum land. After the rain of 1.33 inches on July 5, it seems highly unlikely that any appreciable difference in soil moisture could exist in the top 6 inches of either the fallow or sorghum field on July 6. On July 6 the sorghum land produced more runoff per acre than the fallow land. The reason may be that the sorghum field was still bedded in ridges and furrows which were parallel to a terrace with a uniform grade of 0.1 foot per 100 feet. Apparently, the steep sides of the beds shed water which is concentrated in the furrow to drain out the end or across at a gully in the field. Water intake rate for wet Pullman silty clay loam soil is very low (usually less than 0.1 inch per hour); therefore, a concentration of water would contribute toward greater runoff due to a reduced surface area covered by water. After July 6 the runoff from the sorghum field was less than from the fallow field. This is probably due to rapid water use from the soil by the growing sorghum crop. The combination of stubble cover and dry soil may account for the small amount of runoff from the wheat field.

One year's data seem to indicate that a sorghum crop growing in listed land has little beneficial effect toward reducing runoff other than its capacity for drying the soil by transpiration. Due to the nature and amount of precipitation in July, it seems likely that runoff was higher for 1958 than could be expected in an average year. However, it should be pointed out that precipitation in the southwestern Great Plains is nearly always erratic with months above and below average in most calendar years. Predictions of "normal" runoff are generally in error when based on 1 year's results, although apparently average runoff is not likely to exceed 1.5 inches per year. (I-A-2, IV-A-1, V-A-2, and V-B-1)

Runoff from terraced hardlands, USDA Southwestern Great Plains Field Station, Bushland, Texas, 1958

Date	Rainfall	Runoff					
		Fallow		Grain sorghum		Wheat	
	Inches	*Inches*	*Percent*	*Inches*	*Percent*	*Inches*	*Percent*
May 25.....	0.56	0	0	0.01	1.8	0	0
27.....	0.50	0	0	T	---	0	0
July 5.....	1.33	0.03	2.2	0.29	22.0	0	0
6.....	2.00	0.81	40.6	1.12	55.8	0.03	1.6
21.....	1.15	0.31	27.1	0.26	22.4	0.01	0.6
23.....	0.30	0.04	14.3	0.01	12.7	0	0
25.....	1.23	0.60	48.6	0.54	44.1	0.10	8.5
26.....	0.98	0.49	50.0	0.40	40.4	0.13	13.0
27.....	0.54	0.23	42.2	0.18	32.6	0.02	2.8
August 9.....	0.25	T	---	T	---	T	---
Total......	8.84	2.51	28.4	2.81	31.7	0.29	3.3

Indiana

RESIDUAL VALUE OF SOD IS GREATEST WHEN MOST NEEDED

W. H. Wischmeier, Lafayette.--The residual erosion control effect of a good grass and legume sod turned under shortly before corn planting is the greatest and most needed during the corn seedbed period. It declines progressively throughout the year. In relation to continuous corn the effectiveness of the plowed meadow decreases as the time interval between plowing and the occurrence of erosive rainstorms increases.

The variation in residual value of sod is apparent from 66 location-years of basic data comparing soil losses from continuous corn with corresponding losses from first-year corn after one full year of grass and legume meadow. The 66 location-years include all comparisons of the 2 management practices which were available from the large volume of basic soil-loss data assembled at Lafayette from 36 research projects. Six major soil types with slopes ranging from 4 to 17 percent were represented.

Differences in soil loss from corn in the two crop sequences do not appear to have been significantly influenced by soil type or land slope. In order to equalize the weights of the various localized studies, all soil losses were adjusted to unity soil erodibility and 9 percent slope before averaging. The number of years, soils, and climatic conditions sampled in the study may be reasonably assumed adequate to avoid serious bias by random variables which are beyond the control of farm managers.

The data in the table show that the reduction in soil loss from corn due to residual effect of preceding-year meadow declines with each successive cover period after the spring plowing date. They also show that the residual effect, although greatly reduced, is still existent after corn harvest.

This information is important because the length of time from turnplowing to the period when most of the highly erosive rains are normally expected differs from various geographic areas. The annual reduction in erosion due to residual effect of the meadow is greater in areas where most of the erosive rains normally occur during the first month or two after corn planting, than it is in areas where they usually do not occur until later in the growing season. (IV-A-1)

Residual effect of meadow on soil loss from succeeding corn at 36 research locations

Cover period	Location-years of data	Average soil loss per acre[1]		Soil loss reduction by rotation
		Continuous corn[2]	Rotation corn[3]	
	Number	*Tons*	*Tons*	*Percent*
Rough-plow period (Turnplow to corn plant).............	54	4.28	0.83	81
Corn seedbed period (Plant to 1 month)...................	66	9.44	2.69	72
Establishment period (1 to 2 mos. after plant)............	66	7.42	2.63	65
Established-growth period (2 mos. after plant to harvest).......	58	8.45	4.97	41
Corn stubble (Stalks removed).....................	23	3.03	1.94	36

[1] Yearly average, adjusted to 9 percent slope on soil with erodibility factor of one.
[2] Third or more successive year of corn.
[3] First-year corn following one full year of grass and legume mix harvested for hay, and spring turnplowed before corn planting.

Georgia

CRIMSON CLOVER PROVIDES POOR WINTER PROTECTION FROM EROSION

A. W. White, Jr., Tifton. --Although favorable weather conditions prevailed during the 1958-59 winter season, the new fall planting of crimson clover provided comparatively poor protection from soil and water losses on a 3-percent slope of Tifton loamy sand. Similar results have been secured in previous years in a meadow-meadow-corn and peanuts rotation. In the meadow of Pensacola-Bahia-crimson clover it was not until early summer when Pensacola-Bahia grass became well established that a good protective cover was obtained.

The data in the table show the recorded soil and water losses from various surface conditions during January, February, and March of 1959. Rainfall during those months was quite high, totaling 19.90 inches compared with a normal of 12.19 inches. Although the losses may not be considered high, the effects of the various surface conditions are quite apparent. (IV-A-1)

Soil and water losses Tifton loamy sand, 3-percent slope, January through March 1959

Surface condition	Runoff	Soil loss per acre
	Inches	*Tons*
Crimson clover, fall planted on harrowed seedbed.......	0.55	0.60
Winter fallow after peanuts..........................	.49	.26
Drilled rye after peanuts............................	.15	.17
Drilled oats in harrowed corn stubble................	.11	.21
Harrowed grass sod, 2-year-old Bahiagrass............	.04	.11
Drilled rye on harrowed oats stubble.................	.03	.11
Corn stubble and corn crop residue on surface........	.01	.04
Established grass-clover sod (Bahiagrass and crimson clover)..	.01	.02

Wisconsin

LESS EROSION OCCURS FROM GRADED ROWS IN STRIPCROPPING

Orville E. Hays, LaCrosse. --Soil loss has been consistently lower from graded strips, than when the strip was on the exact contour, but runoff was higher with the graded strips. Average annual soil losses have been 2.2 and 1.2 tons per acre respectively from the contour and graded strips, and the average runoff was 1.0 and 1.4 inches. These averages cover the 7-year period, 1952-58.

During intense rainfall, the water overtops the contour rows, whereas the graded rows tend to direct the runoff toward the waterways. This difference in overtopping of rows influenced strip rilling as shown in the following table.

These data are from two small watersheds at LaCrosse, Wisconsin, that are similar but not identical. The strip width and number of strips are the same for the two watersheds. The strips on one were on the true contour, but on the other, they had a 2-percent grade toward the waterway. Plowing of the strips for corn was up slope with a two-way plow. Soil treatment was above average, and the rotation since 1954 was corn-meadow-meadow. (IV-B-1)

Rilling in stripcropped fields, LaCrosse, Wis.

Strip number	Rill area per 100 linear feet	
	Contour	Graded
	Square inches	*Square inches*
1 (top).........	34	57
3...............	167	29
5...............	207	53
Total...........	488	139

Georgia

EROSION LOSSES WERE HIGH FROM ROADSIDE AREAS

Ellis G. Diseker, Cartersville.--Heavy erosion losses ranging from 21 to 86 tons per acre occurred on unprotected highway cut slopes, roadbanks, and ditches in Northwest Georgia during 1958. Losses resulted from both rainfall and frost action and were greatest on northwest-facing slopes.

During the past three years, frost action from the middle of December to February 15 has contributed greatly to the highway erosion problem. Upon thawing, great quantities of loosened soil rolled from steep banks to the bottom of the slope. Additional amounts of the loosened soil were later washed down the banks by runoff.

Orientation of roadbanks apparently contributed greatly to frost action and erosion. All experimental plots facing the northwest yielded higher losses than those facing the southeast. Observations have indicated that rains move into this area from a westerly direction, which means that a bank facing the west may receive more direct beating action of the rain than a bank facing the east. Banks facing north and northwest do not dry out as readily; hence, are more vulnerable to freezing.

Runoff and erosion losses were measured from six experimental roadside plots consisting of the unvegetated ditches and cut bank slopes. Runoff measurements included that from the vegetated road shoulders. The plot areas were adequately enclosed by small vegetated diversion dykes. Plot sizes of runoff areas varied from 0.16 to 0.30 acres. The non-vegetated or erodible portion of the plots varied from 0.11 to 0.21 acres. Lengths of plots ranged from 206 to 365 feet with bank heights of 10 to 16 feet at the highest points.

The annual runoff and soil losses from the six plots in 1958 are shown in the table. (IV-D-3)

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Runoff and erosion from bare roadside cuts and flow channels Cartersville, Georgia, 1/1/58 to 12/31/58, inclusive

Plot description[2]	Rainfall	Runoff	Soil losses per acre			
			Total runoff area[1]	Bank and ditch[4]	Channel deposition	Total from area[3]
	Inches	*Inches*	*Tons*	*Tons*	*Tons*	*Tons*
PLOT I. Cecil subsoil bare Runoff area 0.16 ac.; erodible 0.11 ac.; bank slope 1.4-1 faces N 70 W; bank height 5' to 16';length 206'.	49.60	5.64	20.7	27.7	57.9	85.6
PLOT II. Cecil subsoil bare Runoff area 0.27 ac.; erodible 0.21 ac.; bank slope 1.25-1 faces S 70 E; bank height 5' to 14'; length 255'.	49.60	6.22	21.0	25.7	12.1	37.8
PLOT III. Madison subsoil bare Runoff area 0.21 ac.; erodible 0.16 ac.; bank slope 2.5-1 faces N 70 W; bank height 2' to 10'; length 365'.	41.65	7.89	69.9	86.5	([3])	86.5
PLOT IV. Lloyd subsoil bare Runoff area 0.30 ac.; erodible 0.20 ac.; bank slope 3.3-1 faces S 70 E; bank height 2' to 12'; length 310'.	41.65	3.65	30.7	40.5	([3])	40.5
PLOT V. Cecil subsoil bare Runoff area 0.18 ac.; erodible 0.12 ac.; bank slope 1-1 faces N 70 W; bank height 4' to 15'; length 296'.	41.65	3.90	16.7	22.6	([3])	22.6
PLOT VI. Cecil subsoil bare Runoff area 0.23 ac.; erodible 0.15 ac.; bank slope 1.1-1 faces S 70 E; bank height 5' to 15'; length 321'.	41.65	3.15	15.7	21.3	([3])	21.3

[1] Total runoff area includes bare roadbank ditch and vegetated road shoulder.

[2] Actual bare erodible area includes bank and ditch only which is approximately one-third less in size than the total runoff area; hence, greater losses per unit area are shown from bank and ditch.

[3] Soil losses tons per acre total from area is that from ditch and bank plus channel deposition.

[4] Erosion occurred in ditches with the exception of slight deposition in the upper end.

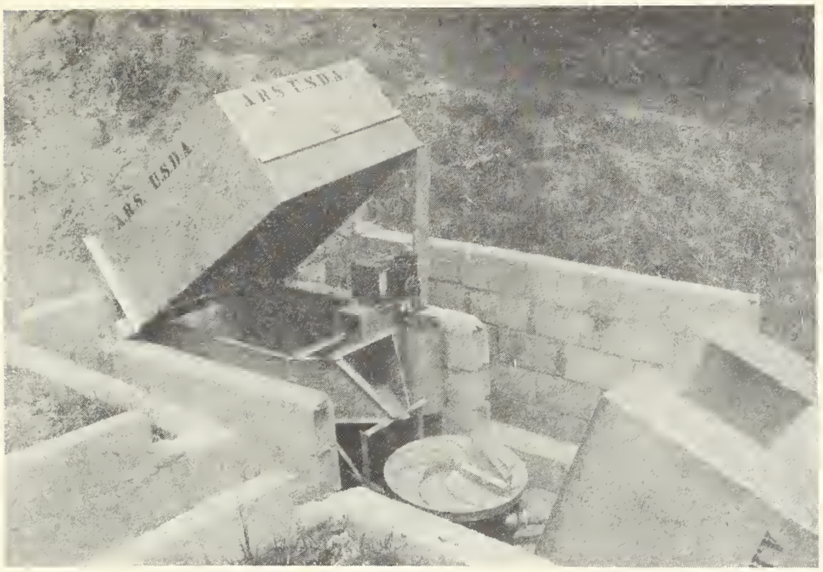


Figure 1. --A detailed view of the soil and water sampling devices with the latest type, two-section cover, opened. Step entrance down to device is shown in the foreground.

Figure 2. --Overall view of one of the plots including the measuring device. Note the 54 cubic foot collecting tank with two-section cover, closed, at the right front.

WATER INTAKE MEASURED ON SMALL RANGELAND WATERSHED IN S. DAK.

Frank Rauzi, Laramie. --Water intake studies conducted near Newell, Butte County, South Dakota, showed that increased total plant and residue cover on a shallow shale range site materially increased the amount of artificial rainfall absorbed.

During July 1958, 24 tests were conducted on a small rangeland watershed using a mobile infiltrometer. The watershed is located about 12 miles east of Newell in the 10- to 14-inch rainfall belt. Soils were identified as the Lismas series which are fine-textured lithosols. A mechanical analysis of several composite samples from the 0- to 6-inch soil depth of the test plots averaged 85 percent silt, 6 percent clay, and 9 percent sand. Variations in texture between the composite samples were negligible. Average soil moisture for the 0- to 6-inch depth at time of the tests was 17 percent.

Dominant vegetation on the watershed was Western wheatgrass interspersed with a thin scattering of other grass species and forbs. The watershed and adjoining areas were grazed by sheep throughout the summer months and were in "good" range condition. At the time of testing in July large soil surface cracks were observed. Undoubtedly, these cracks affected the rate of water intake during the first few minutes of the tests.

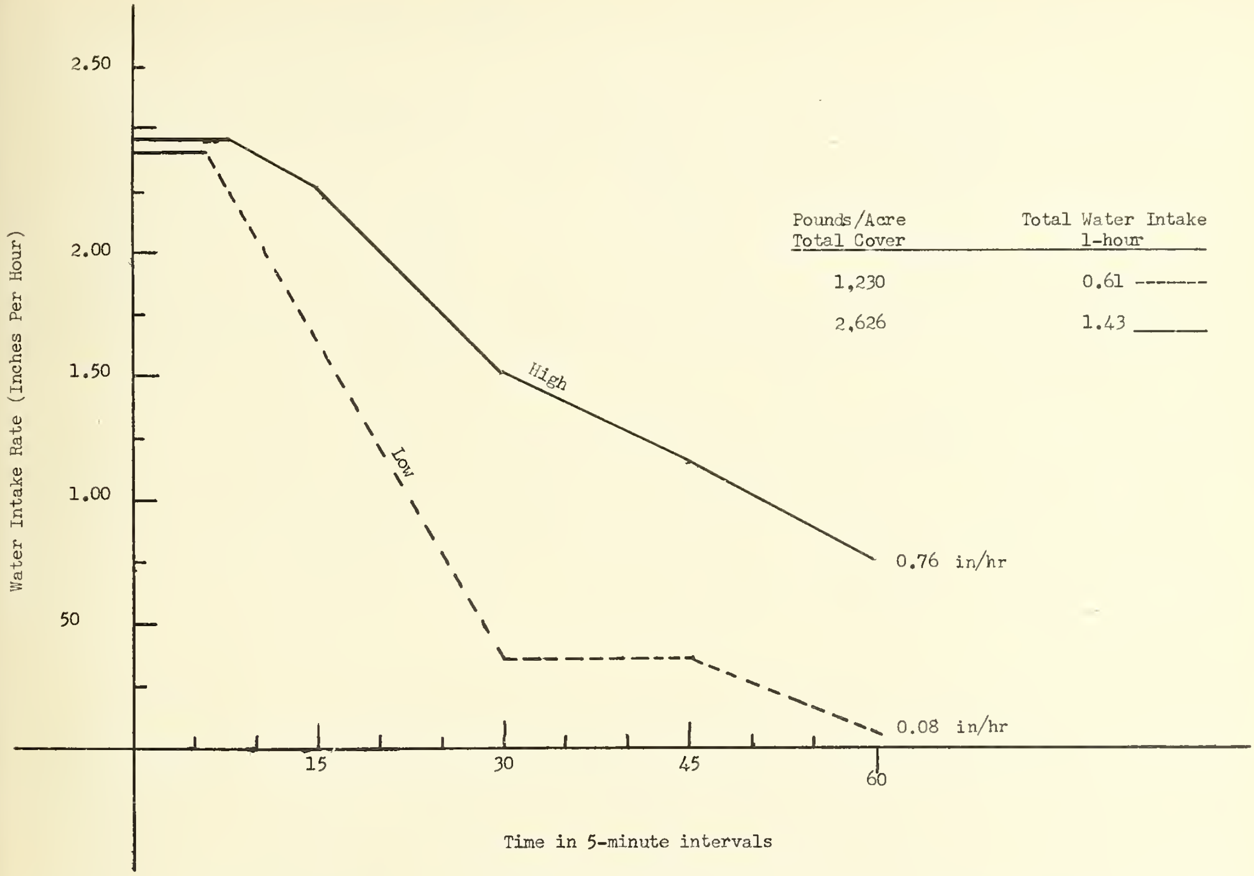
Average water intake rate for the 24 tests during a 1-hour period was 1.02 inches. A correlation between water intake and pounds per acre total cover was determined to be statistically significant at the .01 percent level and showed that 70 percent of the variation in water intake during the 1-hour period was accounted for by variation in total cover.

For purpose of comparison, the test plots were grouped equally in number to: (a) low-cover condition (less than 2,000 pounds per acre total cover), and (b) high-cover condition (2,000 to 3,000 pounds per acre total cover). The average for the low-cover condition was 1,230 pounds per acre as compared to 2,626 pounds per acre for the high-cover condition. Mulch material accounted for 21 and 18 percent of the total cover, respectively, for the low- and high-cover conditions.

Water intake rates for the high- and low-cover conditions are presented graphically in the accompanying figure. Rate of water intake decreased more rapidly on the low- than on the high-cover condition. Total amount of water absorbed under high-cover condition during the 1-hour test averaged 1.43 inches, whereas only 0.61 inch was taken in on the low-cover condition test plots.

Average rate of water intake during the last 15-minute period of the 1-hour test for the low condition was 0.08 inch per hour as compared to 0.76 inch for the high-cover condition.

Total cover on the low-cover condition was not sufficient to protect the soil from raindrop impact and, thus, the soil puddled and sealed over quickly. It appears from this study that for maximum water intake on Lismas silty soils there should be 2,000 pounds or more total cover per acre. (VI-B-6)



Water intake rates as influenced by different quantities of total cover (standing vegetation and mulch material) on a watershed located 12 miles east of Newell, South Dakota, 1958.

SOIL FERTILITY

Arkansas

LIME INCREASES LADINO CLOVER YIELDS

C. L. Parks and C. D. Foy, Marianna and Fayetteville.--Dolomitic and calcitic limestone applied at rates of 1 to 8 tons per acre 6 weeks before seeding have significantly increased yields of Ladino clover on a loessial hills soil at Colt, Arkansas.

The soil used was Loring silt loam having an initial pH of 5.1. Fertilization was 1,000 pounds of 0-20-20 broadcast prior to planting in the fall of 1957.

Lime treatments and yield of clover for 1958 are shown in the accompanying table. Yields reported are averages for four replications. All rates of lime and 1 to 8 tons significantly increased yields over the no-lime treatment. Maximum yield was obtained with the 2-ton rate which was significantly better than the 1-ton rate. Yield differences between sources and placements were not significant.

At Marianna on Richland silt loam (pH=5.1) and at Warren on Ruston sandy loam (pH=4.9), Ladino clover did not respond to lime. At these locations liming and fertilization treatments were identical to those at Colt, where lime responses were obtained. Preliminary greenhouse results indicate that on these two soils the large initial phosphate application used (200 lbs. P_2O_5/acre) may have masked the expected response to lime during the first year. (III-C)

Effect of rate, source, and placement of lime on yields of Ladino clover on Loring silt loam, Colt, Ark., 1958

Lime per acre	Yield of 2 cuttings dry forage per acre			
	Dol. surface**	Dol. mixed+	Cal. surface**	Average
Tons	*Pounds*	*Pounds*	*Pounds*	*Pounds*
0..........	1,899	1,953	1,925	1,926
1..........	2,296	2,620	2,064	2,327
2..........	2,529	2,798	2,707	2,678
4..........	2,563	2,566	2,466	2,532
8..........	2,351	3,057	2,136	2,515
4*.........	2,492	2,234	2,656	2,464
Av.........	2,355	2,540	2,326	

*To be re-limed when pH falls 0.5 unit below maximum attained after original lime application.
**Disked into soil surface.
+Plowed under.

Pennsylvania

CROPS MAY BE PRODUCED ON SOILS WITH TOXIC SUBSOILS

W. V. Chandler, University Park.--The yield of field crops may be drastically reduced by aluminum or other toxic substances in the subsoil. However, if adequate nutrients and water are supplied by the surface few inches of soil, the yields need not be reduced. In recent tests, plants were grown in a very limited quantity of surface soil over, but separated from, a complete nutrient solution containing either a non-toxic or toxic level of aluminum. The plants grown over the nontoxic nutrient solution, produced a large volume of fine fibrous roots in the nutrient solution; whereas those over the toxic solution produced no roots in the nutrient solution. However, there were no significant differences in the yield of the crop over either solution.

The evidence suggests that plants grown in an aluminum toxic medium are retarded in growth due to a shortage of phosphorus in the plant. Even though the roots of plants may be grown in a medium containing sufficient phosphorus and absorb a considerable quantity of phosphorus, the phosphorus may be tied up within the root and never reach the growing top. In recent tests, the phosphorus content of the tops of plants were reduced from 2,550 to 2,075 p.p.m. P; whereas the roots contained 4,400 and 8,915 p.p.m. P, when grown in a nontoxic and toxic media, respectively. (III-C)

North Dakota

IRRIGATED CORN LEAF NUTRIENT CONTENT AFFECTED BY FERTILITY

G. A. Reichman, D. L. Grunes, C. W. Carlson, and J. Alessi, Mandan.--Yield increases obtained by fertilizing corn are closely paralleled by the changes in nitrogen and phosphorus content of corn leaves. Leaf composition is frequently a good index of the fertility status of the soil. These conclusions are taken from experiments conducted with corn in 1954 and 1956 on an exposed subsoil (cut area) of Gardena fine sandy loam, and on normal (non-cut area) Gardena loam, at the Deep River Development Farm, Upham, North Dakota. Potatoes were grown in 1955. The key treatments used are shown in tables 1 and 2.

The differences in nitrogen and soluble phosphate contents of the two areas are indicated by the following data for the 0- to 7-inch soil layers:

	Total nitrogen	Sodium bicarbonate soluble phosphorus
	Percent	*P.p.m. P*
Cut area.............	0.098	2.03
Non-cut area.........	.266	11.20

The relationships between the 1954 yields and the fertility treatments were discussed on page 29 of Quarterly Report No. 2, December 1954. Similar conclusions can be drawn from the 1956 yields.

The data in table 1 for 1954 show the effects of fertilization and soil removal on the nutrient concentrations in leaves, and the yields of corn. The second leaf above the ear selected at tasseling is used for analysis. Nitrogen fertilization increased the leaf nitrogen and phosphorus concentrations, and the yields of corn, on the cut area. Nitrogen fertilization of the non-cut area also increased leaf nitrogen and phosphorus concentrations and corn yields but to a lesser extent than occurred on the cut area. On both areas the application of 180 pounds of nitrogen per acre, with phosphorus, resulted in higher leaf nitrogen concentrations than did the application of manure.

Similarly, table 2 shows the effects of soil removal and 1954 and 1956 fertilizer treatments on 1956 corn leaf composition and yields. Both the corn yields and leaf nitrogen and phosphorus concentrations on the exposed subsoil were generally increased by the 1954 fertilizer applications. The yields and leaf nitrogen and phosphorus concentrations were still further increased by the 1956 additions of nitrogen and phosphorus fertilizers.

On the non-cut area there was no consistent effect of either 1954 or 1956 fertilization on the 1956 corn yields. The values for leaf nitrogen and phosphorus were higher on the normal soil than on the denuded area. Apparently, the values were so high that no yield response to applied fertilizer occurred on the normal soil despite the effects of 1954 and 1956 fertilization on increasing the nitrogen and phosphorus concentrations in the leaves.

TABLE 1.--Effect of fertilization on corn leaf nitrogen and phosphorus concentrations, and whole plant yields on surface and subsoil of Gardena soil, Mandan, N. D., 1954

Fertilizer added per acre in 1954			Leaf nitrogen		Leaf phosphorus		Dry matter yield per acre	
N	P_2O_5	Manure	Cut area	Non-cut area	Cut area	Non-cut area	Cut area	Non-cut area
Pounds	*Pounds*	*Tons*	*Percent*	*Percent*	*Percent*	*Percent*	*Pounds*	*Pounds*
0....	100	0	1.68	2.96	0.192	0.328	1,510	5,760
180....	100	0	3.31	3.40	.250	.342	6,420	6,720
180....	0	0	---	---	.187	.306	3,830	6,810
180....	100	0	---	---	.250	.342	6,420	6,720
180....	200	0	---	---	.273	---	6,480	---
0....	0	0	1.77	3.16	.192	.310	1,480	5,900
0....	0	20	1.94	3.17	.226	.348	3,930	6,320
0....	0	40	2.18	---	.234	---	5,470	---
180....	100	20	3.27	3.30	.288	.412	7,940	7,260

TABLE 2.--Effect of 1954 and 1956 fertilization on corn leaf nitrogen and phosphorus concentration and whole plant yields on Gardena surface and subsoil, Mandan, N. D., 1956

Fertilizer added per acre					Leaf nitrogen		Leaf phosphorus		Dry matter per acre	
1954			1956		Cut area	Non-cut area	Cut area	Non-cut area	Cut area	Non-cut area
N	P_2O_5	Manure	N	P_2O_5						
Pounds	*Pounds*	*Tons*	*Pounds*	*Pounds*	*Percent*	*Percent*	*Percent*	*Percent*	*Pounds*	*Pounds*
0...	100	0	0	0	1.67	2.19	---	---	5,150	10,280
180...	100	0	0	0	1.92	2.46	---	---	6,350	10,290
180...	100	0	120	100	2.71	2.40	---	---	9,410	11,080
180...	0	0	0	0	---	---	0.172	0.244	4,860	9,860
180...	100	0	0	0	---	---	.185	.292	6,350	10,290
180...	200	0	0	0	---	---	.189	---	6,500	---
180...	100	0	120	100	---	---	.278	.350	9,410	11,080
0...	0	0	0	0	1.93	2.45	.168	.289	4,530	10,820
0...	0	20	0	0	1.79	2.29	.202	.318	6,500	10,500
0...	0	40	0	0	2.06	---	.223	---	7,340	---
180...	100	20	0	0	1.92	2.36	.252	.334	7,160	10,870
180...	100	20	120	100	2.88	2.80	.277	.361	10,100	10,780

For the experiments during both 1954 and 1956 it is evident that within the range where yield response to applied fertilizer is obtained, the nutrient concentrations in the corn leaves indicate the fertility status of the soil with considerable accuracy. Also, as was reported for another experiment on pp. 13-14 of Quarterly Report No. 13, the leaf nitrogen and phosphorus are increased by fertilization, and the yields obtained are closely related to the nutrient concentrations in the leaves.

It is of additional interest that the maximum leaf nitrogen and phosphorus concentrations on both the cut and non-cut areas were higher in 1954 than in 1956, while the maximum corn yields were higher in 1956. (V-D-1, V-H-1, V-H-2)

Georgia

USE OF SULFUR-FREE FERTILIZER LOWERS LADINO CLOVER YIELDS

A. E. Royer, Fleming.--Four years of continuous cropping with Ladino clover and the use of sulfur-free fertilizers has resulted in the depletion of the sulfur reserves of Bladen clay loam. However, the addition of 4 pounds of sulfur per acre annually has been adequate to sustain yields over this period as shown in the table.

The contribution of sulfur by rainfall is important and may delay the development of deficiencies. At 51 locations over the Southeast, the average annual accretion of sulfur from rainfall varied during a 3-year period from 4.1 to 6.3 pounds per acre per year. Due to losses by runoff and percolation, much of the sulfur reaching the soil in rainfall is not available for plant growth.

With an average annual dry weight yield of 5,000 pounds of Ladino clover per acre analyzing 0.2 percent sulfur, the average crop removal would be 10 pounds per acre. Although this quantity appears small in comparison to some other major nutrients, it is sufficient to cause serious reductions in yields after a few years of no-sulfur treatment.

Thus, the time required to bring about yield reductions due to low soil sulfur is conditioned by variations in soils, seasons, rainfall, location, fertilization, and cropping practices. (V-D-1)

Relationship between sulfur treatments and yields of Ladino clover (16 percent moisture), Fleming, Ga., 1958

Annual sulfur treatment per acre	Ladino clover yield per acre
Pounds	*Pounds*
0	5,345
4	6,525
8	6,509
16	6,159
32	6,646

Puerto Rico

BEEF PRODUCTION DOUBLED BY NITROGEN FERTILIZATION

Ruben Caro, Rio Piedras. --The productivity of Napier grass on steep pastures was more than doubled to 1,275 pounds of beef per acre by increasing nitrogen rates from 100 to 300 pounds per acre yearly.

Pastures on a steep, eroded soil were fertilized with 100, 300, and 500 pounds of N per acre yearly. The nine pastures were grazed in rotation by three groups of Holstein heifers weighed when changed from one pasture to another. Results of the first full year of grazing follow:

Nitrogen applied per acre yearly	Gain in weight per acre yearly	Daily gains per head	Carrying capacity per acre
Pounds	*Pounds*	*Pounds*	*Head*
100	584	1.2	1.2
300	1,275	1.6	2.2
500	1,341	1.6	2.3

Gains in weight, daily gains, and carrying capacity were increased sharply by raising nitrogen rates from 100 to 300 pounds. A further increase to 500 pounds of nitrogen per acre did not appreciably affect productivity. Cost of 200 pounds of nitrogen plus required increase in other nutrients was about $50, compared to a value of $110 for the increase in beef produced per acre.

The application of about 300 pounds of nitrogen per acre yearly to pastures of high-yielding grasses in the humid mountain region of Puerto Rico appears warranted. This conclusion is substantiated by the results of numerous small plot experiments. (V-D-2)

Colorado

FERTILITY RESPONSE RELATED TO ANALYSES ON SOIL REMOVAL PLOTS

B. W. Greb and A. L. Black, Akron. --The 1958 crop season afforded the first opportunity to obtain winter wheat results on the soil removal plot study described on page 13 of Quarterly Report No. 9. Visible vegetative response to fertility treatments was not apparent until early May, and the response was restricted to nitrogen and phosphorus combinations on the plots where the greatest amount of soil had been artificially removed.

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Soil analyses on Weld silt loam surface samples (0- to 2-inch depth) were partially completed during 1957 and the results are shown in table 1, and yield results are tabulated in table 2.

TABLE 1.--Analyses of surface soil from soil removal plots, Akron, Colo.*

Depth of soil removed	$CaCO_3$	pH	P_2O_5 per acre**	Organic matter	Total N	C/N ratio	Nitrifiable N per acre
Inches	*Percent*		*Pounds*	*Percent*	*Percent*		*Pounds*
0-3	0.3	7.2	56	2.1	0.190	11.2	56
3-6	0.4	7.4	36	1.7	.097	10.2	52
6-9	0.5	7.6	22	1.5	.094	9.3	54
9-12	2.5	8.0	17	1.3	.087	8.6	48
12-15	5.6	8.3	11	1.2	.084	8.3	43

*Samples for analyses were taken from the 0- to 2-inch depth shortly after the specified surface depths were removed.
**$NaHCO_3$ soluble P.

TABLE 2.--Response of wheat to different treatments on soil removal plots, Akron, Colo., 1958

Depth of soil removed	Initial stored soil moisture	Fertility	Yield per acre		Test weight grain per bushel
			Grain	Straw	
Inches	*Inches*		*Bushels*	*Tons*	*Pounds*
0-3	5.7	0	21.7	1.46	56.5
		N	16.8	1.38	57.0
		NP	17.2	1.41	57.5
3-6	7.8	0	20.5	1.41	59.0
		N	21.0	1.50	57.5
		NP	18.9	1.53	57.5
6-9	7.4	0	20.9	1.43	58.5
		N	19.2	1.41	58.0
		NP	18.9	1.42	58.0
9-12	8.4	0	20.7	1.51	59.5
		N	21.0	1.52	58.0
		NP	25.9	1.81	59.0
12-15	8.3	0	17.5	1.16	60.0
		N	19.5	1.27	59.0
		NP	24.6	1.72	58.5
LSD (.05)	1.0		3.0	.23	1.7

Total nitrogen and nitrifiable nitrogen decreased with depth in the profile but not as rapidly as organic matter and available phosphorus. Nitrogen was applied at 30 pounds per acre per crop grown and phosphorus was applied at the rate of 100 pounds P_2O_5 per acre in 1956 when the experiment was initiated.

Conclusions:

1. Quantities of initial stored soil moisture at seeding time were significantly lower on the soil having least soil removed.

2. Yield of unfertilized wheat was not reduced until 12 inches of topsoil were removed.

3. Applications of nitrogen alone did not improve yield on any removal plot and did depress yield on the 0- to 3-inch cut.

4. Phosphorus in combination with nitrogen produced a significant increase in grain and straw where 9 or more inches of soil were removed.

5. Test weight of grain increased with water supply and showed some trend to be lower with fertilizer treatments. (V-H-1)

Maryland

STUDIES SHOW EFFECTS OF BACTERIA AND VARIETY ON CHLOROSIS

Ura Mae Means, Herbert W. Johnson, and Lewis W. Erdman, Beltsville.--Further greenhouse experiments on the bacterial-induced chlorosis in soybeans continue to show definite interactions of the soybean variety and strains of nodule-forming bacteria, and suggest the necessity of knowing the actual performance of individual strains on specific varieties of soybeans. Some varieties are more susceptible than others to chlorosis-inducing bacteria as shown in figure 1.

Figure 1. --Effect of 311b76, a chlorosis-inducing strain of bacteria, on nine varieties of soybeans.

In figure 1 nine different varieties of soybeans were inoculated with a single chlorosis-inducing bacterial strain. In the top row, three varieties, Grant, Hawkeye, and Lee showed gradations in chlorosis susceptibility. In the bottom row, two new varieties, one on the extreme left and the other, extreme right, were highly susceptible to chlorosis. Four varieties, Harosoy, upper left jar, and CNS, Blackhawk, and Clark, bottom row, proved resistant to this strain of bacteria.

Lee soybeans were inoculated with six different strains of soybean bacteria and the growth behavior is shown in figure 2.

Figure 2. --Effect of six different strains of soybean bacteria on Lee soybeans.

As shown in figure 2, four strains of bacteria induced severe chlorosis on Lee soybean. One strain produced only slight chlorosis, and the other strain, middle jar on top row, produced normal plants entirely free from chlorosis. Different reactions were noted when other strains were tested on the different varieties.

These results lend support to the theory that specific strains of known performance may be necessary to inoculate successfully a given variety. Field experiments dealing with this chlorosis problem will be made this spring. (VI-C-2)

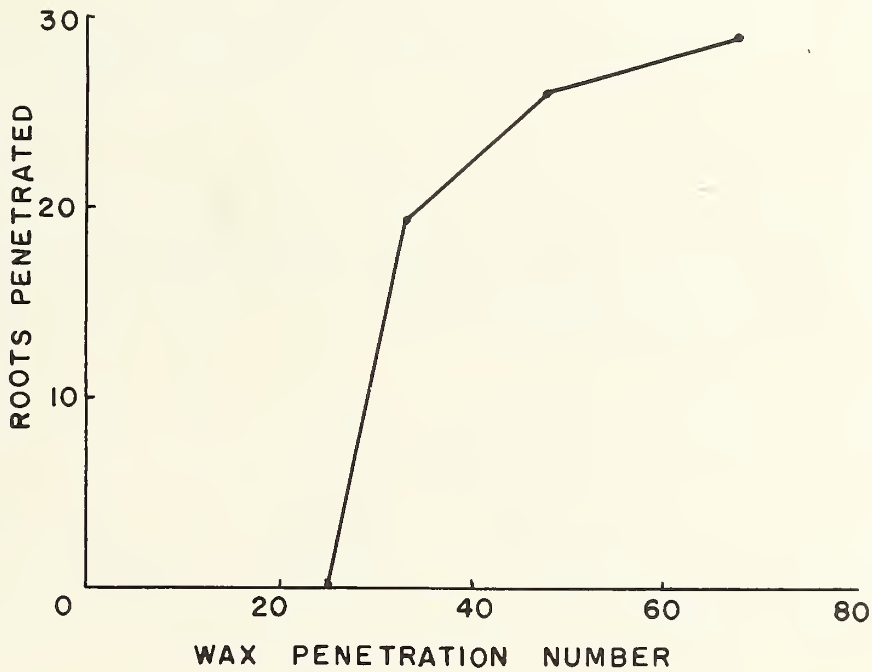
Texas

ROOT PENETRATION DEPENDS ON POROSITY AND PLASTICITY OF SOIL

H. M. Taylor and H. R. Gardner, Bushland.--The ability of plant roots to penetrate thin compacted layers of soil seems to depend on both soil porosity and soil plasticity. In laboratory studies using artificial pressure pans made from Miles fine sandy loam surface soil, the number of sorghum roots penetrating the pan decreased as soil porosity decreased. However, some roots penetrated pans of high bulk density (2.09 gms. per cc.).

In other laboratory studies, corn plants were grown on a number of waxes. As shown in the accompanying illustration, the ability of corn roots to penetrate depended on the wax rigidity. With the softer waxes (higher wax penetration numbers), corn roots could displace sufficient material to create a path. With the harder waxes (lower wax penetration numbers), roots were unable to penetrate the surface.

Moisture content of the pressure pan at the time roots are attempting to penetrate or expand seems to be a controlling factor in effect of these pans on root growth. Many tillage pans are fairly rigid when dry but much more plastic when moist. To penetrate a dry rigid pan, the plant root must be able to find a channel through the pan. If the same pressure pan is moist, however, the root may be able to create its own path through the pan. (III-A-1, -2)



Number of corn roots from 25 seedlings that penetrated the wax surface as a function of wax rigidity. Higher American Society of Testing Materials wax penetration numbers occur as wax softness increases. Bushland, Tex., 1958.

Nebraska

STUBBLE MULCHING INCREASES NUMBER OF SOIL MICROORGANISMS

T. M. McCalla, Lincoln.--A study has been made of the kinds, numbers, and location of microbial populations with stubble mulch with different crops over a period of years and at different stations (tables 1, 2, and 3). When adequate amounts of crop residues are present, the number of microorganisms--such as total bacteria, actinomycetes, fungi, and denitrifiers--generally is higher in the surface inch of mulched soil than on plowed soil. In the 1- to 6-inch depth there appears to be no difference. In many instances, where there is little or no residue left on the surface of the soil, there is no measurable difference between the plow or stubble-mulch system. Organisms, such as earthworms and nematodes, are favored by the cool and moist conditions usually more prevalent with stubble mulching. The azotobacter, legume bacteria, and nodulation did not appear to be affected by stubble mulching. (V-B-1)

TABLE 1.--Mean density of microbial populations within the plow-depth layer of soils in which residues were subtilled and plowed at several stations*

Depth	Subtilled	Plowed	Mean difference
	Fungi in thousands per gram of soil		
Inches			
0-1............	231.08	164.17	66.91** ± 15.98
1-6............	226.83	225.67	1.16 ± 13.41
	Bacteria plus actinomycetes in millions per gram of soil		
0-1............	36.57	20.89	15.68** ± 4.42
1-6............	29.70	29.11	0.59 ± 2.51

*Of the 12 tests included, 6 were obtained from rotation plots, 1 of which received oats straw, and 5 received wheat straw. The remaining six observations were from sweetclover plots. Intervals of time ranging from 5 days to 14 months between applications of residue and sampling for microbial analyses are represented.
**Significant at the 1 percent level.

TABLE 2.--Effect of mulching field plots with straw on the number of earthworms and their activity at several stations

Amount of straw mulch per acre	Earthworms* per acre	Air-dried wormcasts produced per acre**	Wormholes***	
			Number per sq. ft.	Depth
Tons	*Thousands*	*Tons*		*Inches*
0......................	13	1.3	1	12-18
2......................	103	18.7	8	10-12
4......................	169	29.1	18	8-10
8......................	263	41.5	25	6-10

*Mean of biweekly samples for 13 consecutive months.
**Total production of wormcast for 1 year.
***Wormholes under various treatments during August 1948.

TABLE 3.--Influence of stubble mulching on the number of nematodes in land seeded to wheat September 29, 1955, Lincoln, Neb.

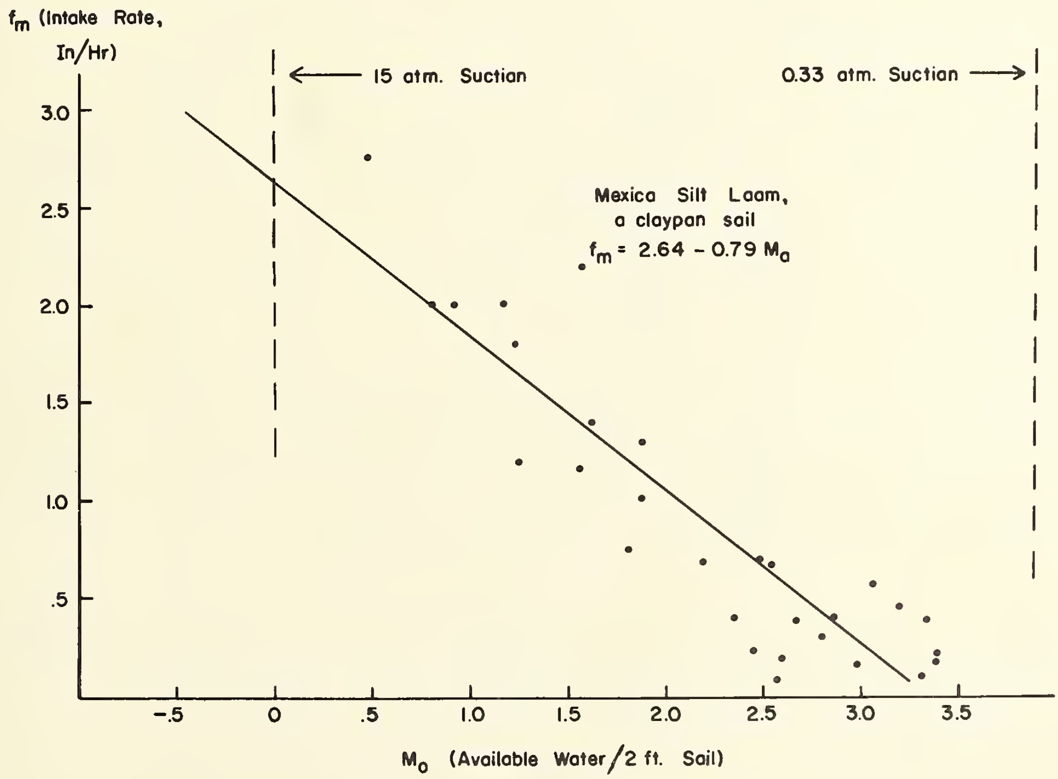
Tillage treatment	Number of nematodes per 50 grams soil	
	0- to 1-inch depth	1- to 6-inch depth
Plowed..............	55	10
Subtilled...........	226	31

MOISTURE CONSERVATION

Missouri

MOISTURE INTAKE DEPENDS MOSTLY UPON SOIL MOISTURE CONTENT

V. C. Jamison and J. F. Thornton, Columbia.--Hydrograph analyses of rainfall-runoff data show that soil moisture content of Mexico silt loam largely determines the maximum intake rate that can be expected and the relative amount of rainfall that will be retained by the soil. Intake rates measured by the analyses varied from more than 3 inches per hour for dry soil to less than .01 inch per hour for wet soil. Differences in moisture retention that arise from various management practices may be partly attributable to differences in antecedent moisture content resulting from differences in vegetative soil cover. The general relationship of maximum intake rate and antecedent moisture for 29 storms at McCredie which could be analyzed for intake rates is shown in the accompanying figure. (II-A-3)



Relationship between soil moisture content and maximum intake rate for 29 storms, McCredie, Mo., 1945-57

HYDRAULIC EXTRACTOR AND SPECIAL TUBES AID MOISTURE SAMPLING

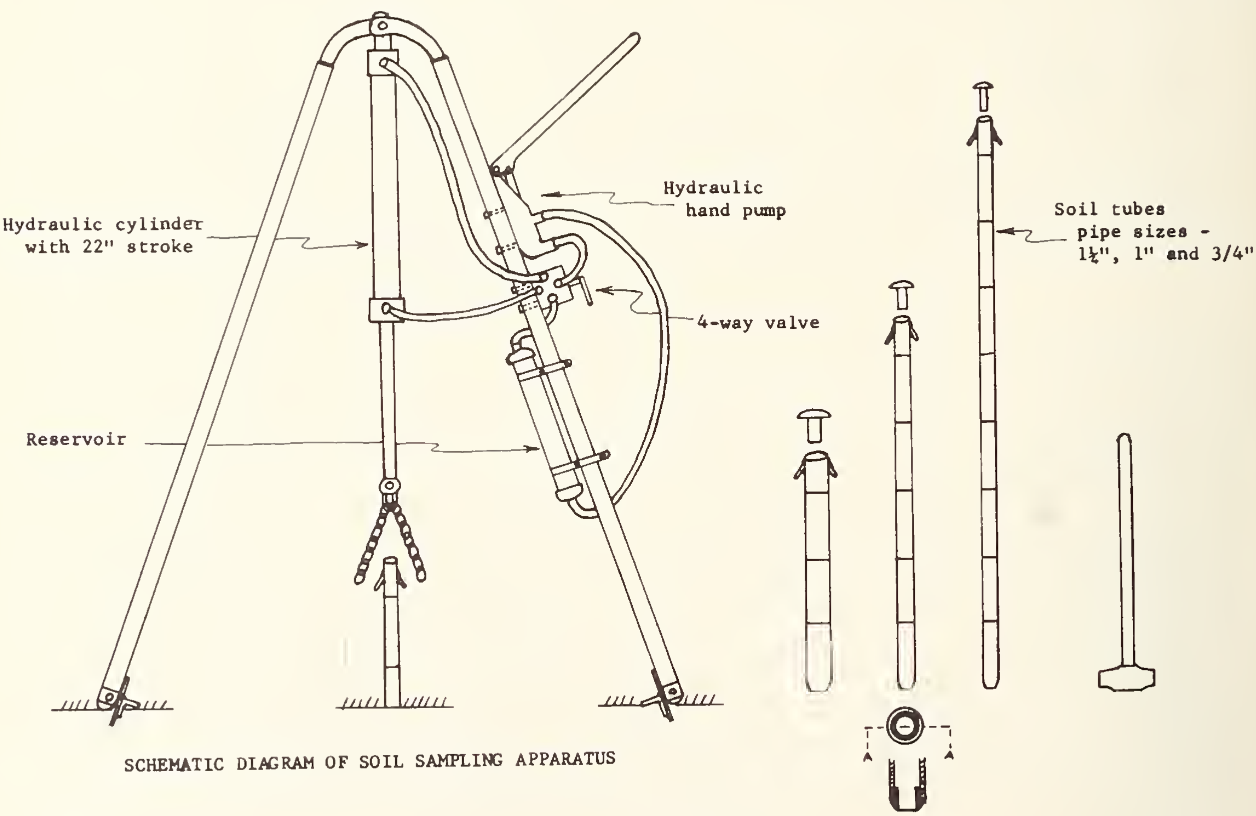
J. Nick Jones, Jr., and J. E. Moody, Blacksburg. --A procedure which employs different size soil tubes and a simple hydraulic apparatus for extracting the soil tubes is proving to be an efficient means for taking soil moisture samples to a depth of 4 feet in soils at the Blacksburg station. Details are shown in the accompanying diagram.

The soil tubes are of three different diameters and lengths. The largest diameter tube is used in sampling to the 18-inch depth; the next smaller size to a depth of 3 feet; and the smallest size to the 4-foot depth. The reduction of tube diameter with depth reduces friction and permits easier driving and extraction of the samples. The tubes are constructed from double-strength black pipe. The cutting edge is formed by placing a short length of a smaller thin-walled tubing on the inside and brazing it to the bottom of the soil tube, then grinding it to an angle to form the cutting edge.

The tubes are driven with a 4-pound hammer. A large-headed steel bolt or rivet placed in the top end of the tube serves as a driving head.

The extractor is made by mounting a hydraulic cylinder between two 5-foot legs hinged at the top. To one leg is fastened a small hydraulic hand pump, a 4-way valve, and a reservoir. Flexible hydraulic hose with fittings complete the system.

The two hooks welded near the top of the soil tube are used to extract it. By placing these hooks through the chain links, a quick and adjustable hitch is made. (III-B-2)



SCHEMATIC DIAGRAM OF SOIL SAMPLING APPARATUS

Texas

IRRIGATED GRAIN SORGHUM YIELDS HIGHER IN NARROW ROWS

K. B. Porter, M. E. Jensen, W. H. Sletten, Bushland. --The effects of four row spacings, two nitrogen levels, and three planting rates on the production and water use of irrigated RS 610 hybrid grain sorghum were studied in 1956, 1957, and 1958. The 12- and 20-inch row spacings produced significantly higher 3-year average grain yields than the 30- or 40-inch spacings on the high fertility level and significantly higher yields than the 40-inch spacing on both fertility levels. Planting rates, which varied from an average of 61,000 to 152,000 plants per acre had little effect on grain yield, but forage yields were directly associated with planting rates. Row spacings had little influence on head weight, heads per plant, and date of first head; but significantly influenced test weight, stalk-grain ratio, threshing percent, and plant height. Head weight and heads per plant were inversely related to planting rate. The high nitrogen level produced the higher yields of grain and forage. There were no significant differences among row spacings or planting rates in total water use, but greater efficiency in water use was obtained with the narrow row spacings. (II-A-1, 2, 5)

The effect of row spacing and plant population on the average grain yield of irrigated hybrid grain sorghum grown with optimum soil fertility, USDA Southwestern Great Plains Field Station, Bushland, Texas, 1956-58

Average plant population per acre	Grain sorghum yield per acre				
	Row spacing (inches)				
	12	20	30	40	Average
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
59,610..............	7,105	6,560	6,331	5,762	6,440
102,690..............	6,946	7,131	6,450	6,070	6,649
150,060..............	6,857	6,857	6,522	5,806	6,510
Average..............	6,969	6,849	6,434	5,879	6,533

LSD (.05)
Row spacing means 390
Plant population means N.S.

Mississippi

SEEDLING EMERGENCE IS INFLUENCED BY SOIL TEXTURE AND MULCHING

Joe O. Sanford and R. R. Bruce, State College. --Emergence of cotton seedlings was less on silty or sandy soils than on soils of finer texture. When mulched, seedling emergence averaged 94 percent without appreciable differences among the textural classes.

Samples of the A_p, B_1, B_2, B_3, and C horizons of five soils from Mississippi Delta were used in the greenhouse trial. Equal volumes of each soil, which had been air dried and crushed to pass a 1/4-inch mesh screen, were potted in No. 10 cans. All soils were brought to the one-third atmosphere moisture percentage and the cultures received no additional water during the course of this trial. Five cottonseed were planted in each can. There were seven replicates of each soil treated as above, and a duplicate set was mulched with chopped Coastal Bermuda-grass hay. The total number of seedlings emerging after 12 days and the number of normal seedlings were determined.

The table shows the number of samples in each textural class, the available water capacity, and percentage emergence of normal seedlings for each of the three groups of soil horizons.

With no mulch the A_p horizons allowed only 48 percent emergence which is significantly lower than the 68 percent observed on the B_1 and B_2 horizons. Seedling emergence from the two groups of subsoil horizons was not significantly different. On the unmulched plots 17 percent of the total seedlings from the A_p samples were damaged; whereas, 10 percent of those emerging from the B_1 and B_2 samples were damaged. Seedling damage consisted in deformity or complete loss of cotyledon leaves, probably caused by the seedling pushing through a hard surface crust.

On mulched treatments there was relatively uniform seedling emergence on all horizons, and no seedling deformity was observed. As an overall average, mulching increased seedling emergence from 60 to 94 percent.

From these data it is suggested that the A_p horizons caused low seedling emergence because of the formation of a hard, dry surface crust. This resulted from the high silt and very fine sand contents and low available water capacities of these horizons. The subsoil horizons have on the average a higher clay content and available water capacity which tend to reduce the seedling emergence problem. Mulching very effectively relieved the seedling emergence problem on all soils. (III-A-2)

Cotton seedling emergence as affected by soil texture and mulch, State College, Miss.

Horizon	Number of samples				Emergence		Available water capacity per inch
	vfsl	sil	sicl	sic	No mulch	Mulch	
					Percent	*Percent*	*Inches*
A_p.............	2	1	2		[1] 48	[1] 96	0.18
B_1, B_2.........	2		1	6	[2] 68	[2] 90	.22
B_3, C..........	2		3		[1] 58	[1] 99	.20
Mean...........					60	94	---

[1] Determined from mean of 35 samples.
[2] Determined from mean of 63 samples.

Oklahoma

STUDY STARTED ON EFFECTS OF DEEP TILLAGE OF A PLOWPAN

L. F. Locke, Woodward, Okla., and H. M. Taylor, Bushland, Tex.--A study to determine effects of deep tilling Pratt fine sandy loam that contains a compacted zone has been initiated at Woodward, Oklahoma. The planned duration of this experiment is 6 to 8 years.

Plots were plowed both at the normal 5-inch depth and at the 12-inch depth with a moldboard plow. Continuous grain sorghum in 3-1/2-foot rows and sand lovegrass in 1-foot rows are being used to evaluate effectiveness of these plants in breaking up the plowpan or keeping open a disrupted pan.

Basin water intake studies were made 3 months after the tillage treatments. Average intake on deep-tilled plots was 2 inches in 24 hours, whereas the shallow-tilled plots took in only 1 inch in 24 hours. However, nearby native pasture on the same soil type infiltrated 16 inches in 2 hours.

Penetrometer measurements indicated large differences at the plowpan depth when comparing deep with shallow tillage, but only small differences were apparent between deep-tilled and native-pasture plots (figure 1).

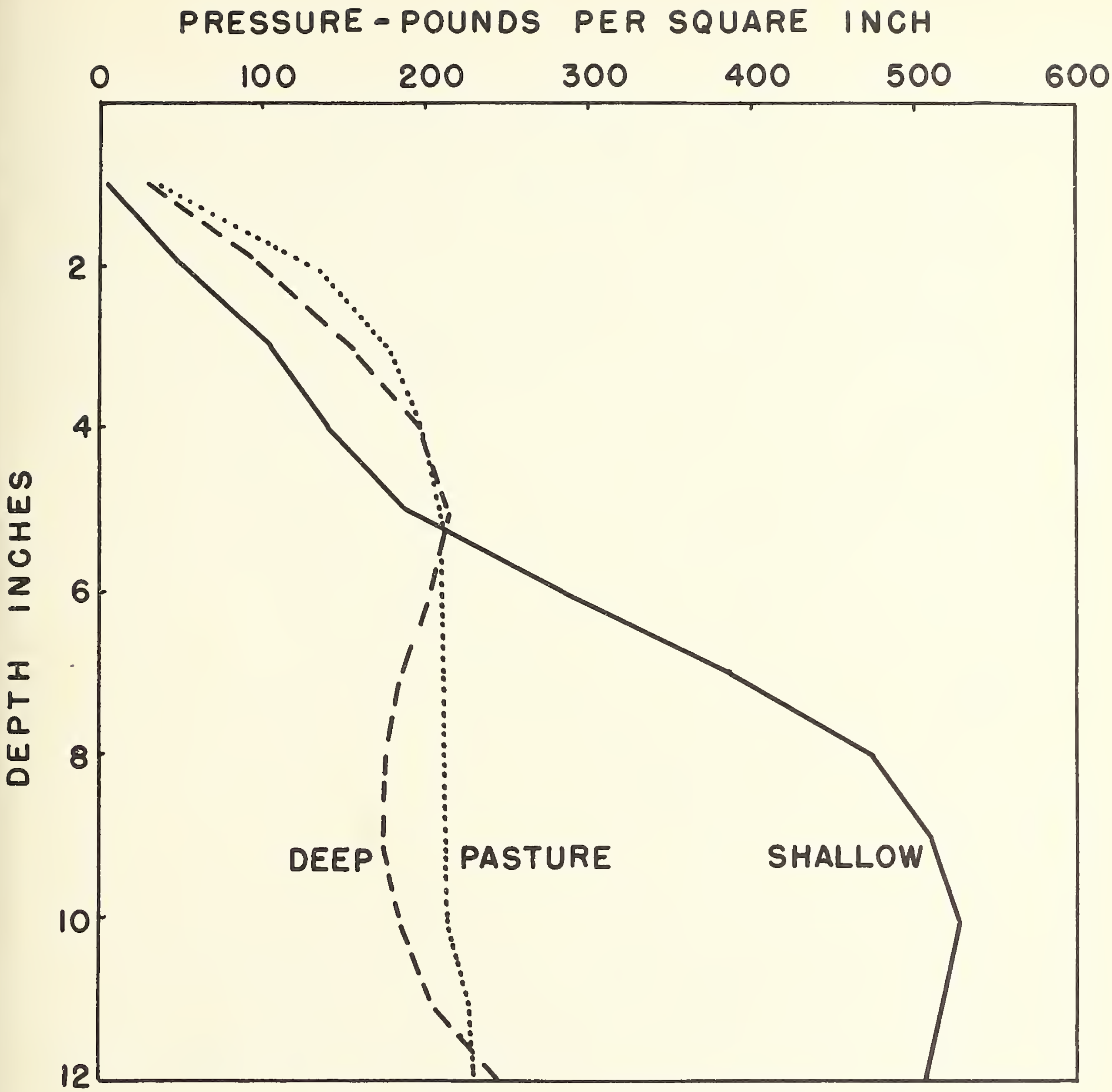


Figure 1. --Penetrometer pressures required within the profile for two tillage treatments and native pasture at Woodward, Oklahoma. (Moisture near field capacity in each case)

Cultivated soil, whether deep tilled or not, had higher bulk densities above 14 inches than the native-pasture soil (figure 2). Deep tillage gave slightly lowered bulk density in the plowpan zone of the cultivated soils.

On this soil, deep tillage was not effective in bringing the soil to the same physical condition as soil under native pasture but did slightly increase water intake and reduce soil resistance and bulk density. (III-A-2, V-A-1 and V-C-1)

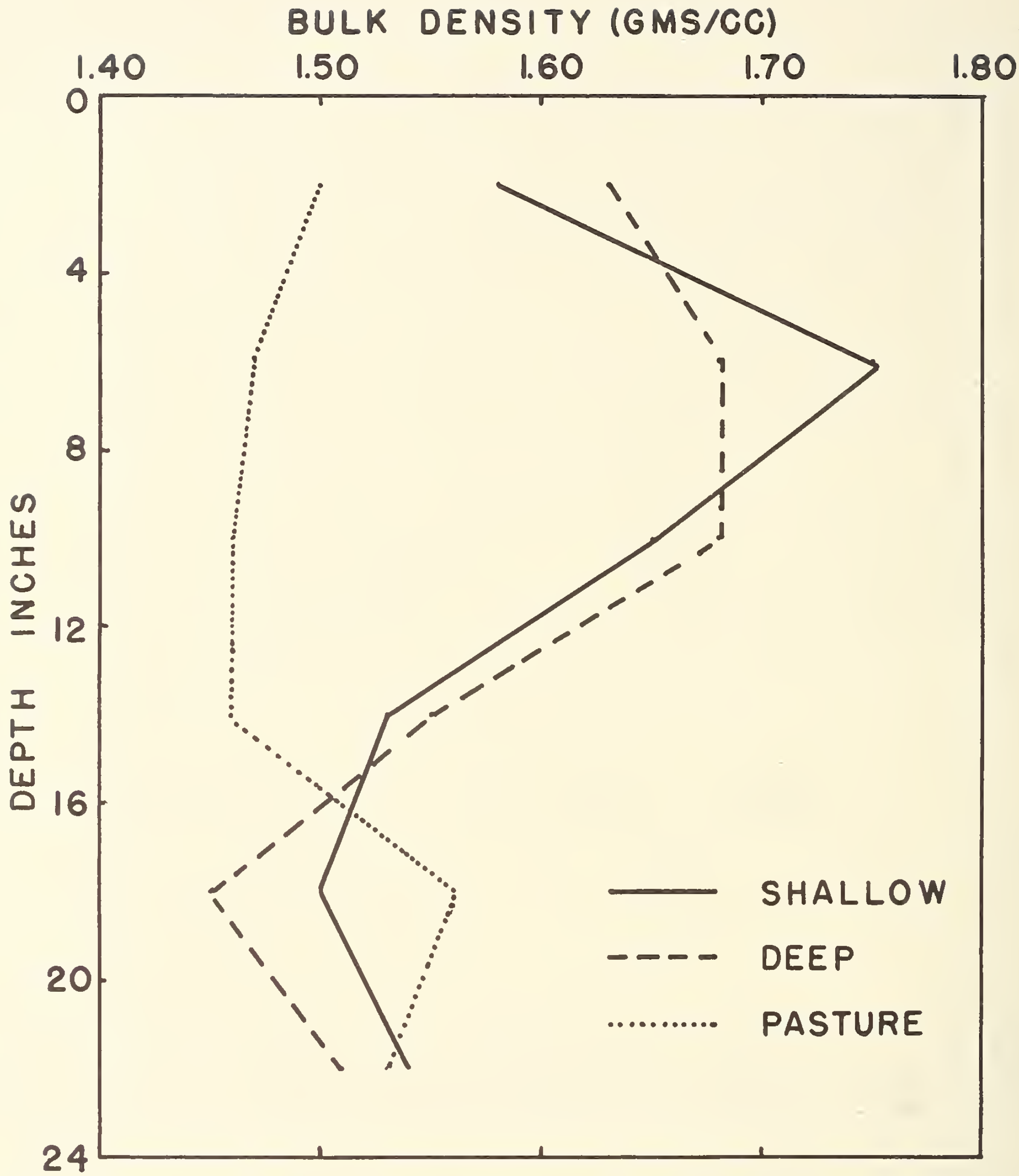


Figure 2. --Bulk density within the profile for two tillage treatments and native pasture at Woodward, Oklahoma.

Texas

EFFECT OF TILLAGE IMPLEMENTS ON MEASURED SURFACE RESIDUE

Carl D. Fanning and Harold V. Eck, Bushland. --The value of surface residues for wind erosion control has been well established. Surface residue measurements made following the 1958 wheat harvest show that 30-inch sweeps left far more crop residue on the soil surface than either a field cultivator or a one-way plow.

Straw yields and percentages of those yields remaining on the soil surface after first tillage and after seeding are shown in the accompanying table. All plots were tilled three times between harvest in June and seeding in October. The first tillage with the field cultivator was with chisel points and the two subsequent ones were with 12-inch sweeps. The 30-inch sweeps and the one-way were used exclusively on their respective plots. The "after seeding" measurements were made after the plots were planted with a shovel-type grain drill with 10-inch row spacings. (V-B-2)

Effect of tillage implements on surface residues, USDA Southwestern Great Plains Field Station, Bushland, Texas

Tillage implement	Straw yield per acre	Proportion of straw remaining on surface	
		After first tillage	After seeding
	Pounds	*Percent*	*Percent*
30-inch sweeps..............	2,600	82	54
Field cultivator............	2,640	56	30
One-way.....................	2,470	30	12

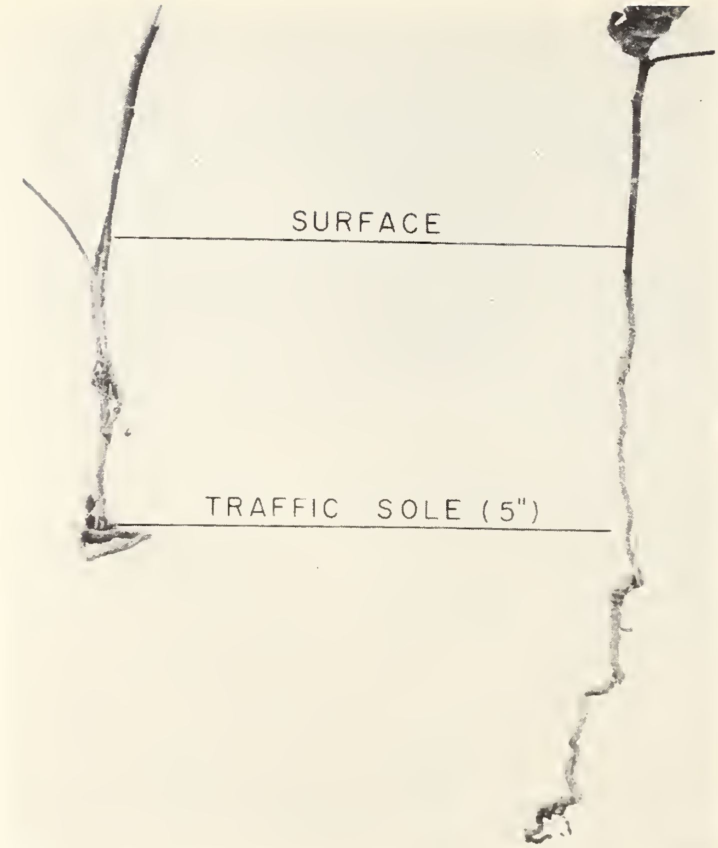
Alabama

WEEDS MAY HELP TO LOCATE TRAFFIC SOLES

W. R. Gill and J. T. Cope, Auburn. --The roots of weeds, as well as those of crop plants, may be used to detect the presence of compacted soil layers. The presence of turgid weeds during drought periods may indicate that those plants are securing moisture which is not available to adjacent crop plants. In the accompanying photograph, the plant on the left had its roots completely stopped by the physical barrier of a traffic sole. The plant on the right was seriously impeded by mechanical resistance, however, it extended through the traffic sole. These plants were grown in a Prentiss very fine sandy loam on the Aliceville Experiment Field of the API Experiment Station.

In general, the paths of the root growth were straight in the loose soil above the traffic sole, while the paths in the compacted layer were tortuous. Since perennial and biennial plants had root systems established below the plowed layer, they were able to use soil moisture and remain turgid, whereas, the annual crop plants were unable to use the moisture because of the mechanical barrier that was created by the traffic sole.

Crop plants in the same area did not show such outstanding root restriction, but their limited rooting depth resulted in severe moisture stress in the plants. Thus, the abnormalities in rooting of different plants, including those of weeds, should be used to evaluate the mechanical restriction of roots by traffic soles. (V-C-1)



The effect of mechanical resistance on the penetration of the roots of Horse Nettle, Solanum Carolinense, Prentiss very fine sandy loam, Aliceville, Ala.

Iowa

TILLAGE INFLUENCES CORN EMERGENCE AND MATURITY

W. E. Larson, Ames.--The method of seedbed preparation can have a marked effect on the development and maturity of corn.

Corn grown where the seedbed was prepared by five different tillage methods have been compared at a number of locations in Iowa for several years with respect to date of emergence, date of silking, and moisture in the grain at harvest. The data for a northern Iowa, Lyon County, and a southern Iowa, Ringgold County, location in 1958 are given in the table.

Emergence, silking, and moisture in the grain have not been noticeably different between conventional (plow, disk, harrow, surface plant) and wheeltrack planting. In northern Iowa listing markedly delayed emergence and silking and increased the moisture in the grain at harvest time. For example, in Lyon County corn in listed plots emerged 4 days later, silked 6 days later, and contained 6.7 more moisture in the grain at harvest than corn in conventional treatments. Mulch tillage had the same effect but to a lesser degree. Ridge planting (where all residues are on the surface) had little effect on date of emergence or silking but tended to result in lower grain moisture at harvest. In other experiments where all residues were turned under, ridge planting has noticeably speeded emergence and silking and lowered the moisture content of the grain at harvest as compared to conventional. The differences in development and maturity due to seedbed preparation are much less in southern than northern Iowa.

Effect of tillage method on development and maturity of corn in Iowa, 1958

Tillage treatment	Lyon County[1]			Ringgold County[1]	
	Emergence[2] days from planting	Silking[3] days from planting	Moisture in grain at harvest	Silking[3] days from planting	Moisture in grain at harvest
			Percent		*Percent*
Conventional...........	10	74	20.4	84	25.2
Wheel-track............	10	75	20.4	84	25.6
Mulch..................	11	77	23.0	84	26.1
Listing................	14	80	27.1	86	26.5
Ridge..................	11	76	18.1	84	24.8

[1] Experiments in Lyon, and Ringgold County planted on May 13 and 1, respectively.
[2] Date at which 75 percent of plants emerged.
[3] Date at which 75 percent of plants silked.

It is believed that earliness of maturity is related to soil temperatures in the spring. Tillage methods where the soil warms readily in the spring hasten the development and maturity of corn. Soil temperatures are cooler in northern Iowa; hence, differences due to tillage are larger.

Where full season hybrids are desired, or in years of early frost, tillage methods resulting in early maturity are desirable. (V-C-3)

Nebraska

ALFALFA STAND ESTABLISHED WITH CORN AS COMPANION CROP

O. W. Howe, Mitchell.--An excellent alfalfa stand was established in corn yielding 130 bushels per acre where 20,000 plants per acre grew in rows 42 inches apart. Larger growth of seedlings occurred where 15,000 corn plants per acre in 60-inch rows yielded 108 bushels per acre. Alfalfa did not get a good start where 25,000 corn plants per acre in rows 30 inches apart yielded 140 bushels per acre, the highest corn yield of the experiment.

From the standpoint of grain and silage yields there would appear to be no advantage in planting corn in alternating narrow (12-inch) and wide (30- or 48-inch) rows as compared with 42-inch rows. Whether or not any advantage from such plantings will accrue to alfalfa stands cannot be determined until the spring of 1959 when density and vigor of the established alfalfa stands will be evaluated.

These studies were conducted in level irrigation basins on Tripp very fine sandy loam. (V-A-1, VI-A-1)

SOIL AND WATER MANAGEMENT--GENERAL

Puerto Rico

FERTILIZATION REDUCES SOIL COMPACTION IN PASTURES

Servando Silva, Rio Piedras.--Surface soil of Pangola and Para grass pastures, heavily fertilized with nitrogen, had greater permeability and a higher proportion of large pores than that of unfertilized pastures.

Cores were taken from the upper 3 inches of Catalina clay in replicated plots of intensively grazed Pangola and Para grass receiving 0, and 800 pounds of nitrogen per acre yearly. Cores were also taken from ungrazed plots of Pangola grass for comparison. Saturated percolation rates and percent of large pores were determined with the following results:

Grass and fertilizer treatment	Saturated percolation rate	Pores drained at 60 cm. tension
Pangola grass	*Inches/hour*	*Percent*
0 N	1.5	6.5
800 lbs. N per acre yearly	3.9	9.0
Para grass		
0 N	1.9	7.7
800 lbs. N per acre yearly	2.8	9.0
Pangola grass harvested by cutting and receiving		
800 lbs. N per acre yearly	10.2	13.9

Considerable compaction of soil resulted from trampling of the livestock in all cases. However, much better physical condition was maintained when heavy fertilization with nitrogen was practiced, probably as a result of increased growth of stems, leaves, and roots. (III-A-2)

New York

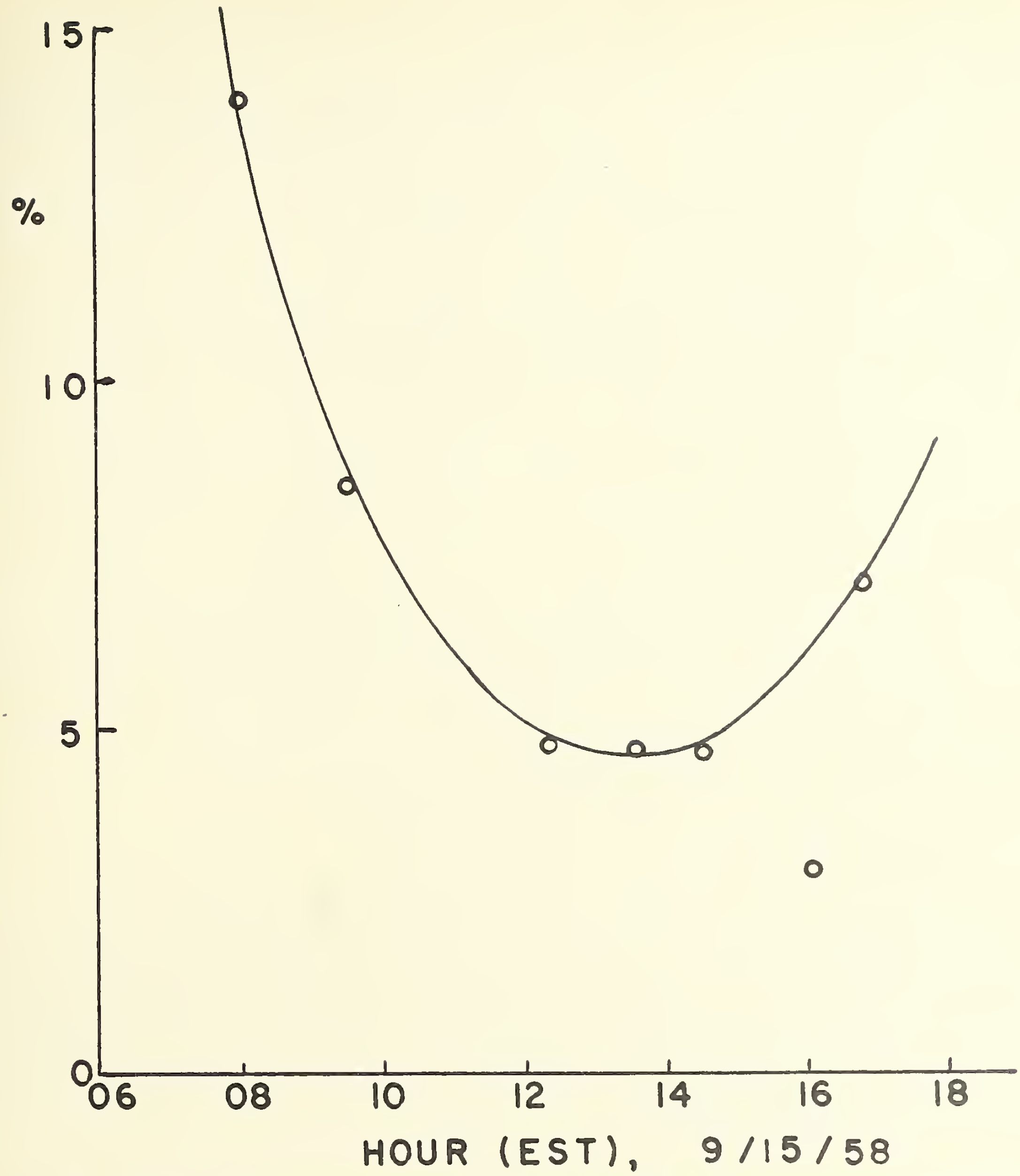
HOW EFFICIENT IS THE PHOTOSYNTHETIC PROCESS IN A CORNFIELD?

E. R. Lemon, Ithaca.--Recent studies have shown that micrometeorological methods and theories may be used to estimate the photosynthetic rate of a large cornfield. This estimate can be made by utilizing the naturally occurring windspeed gradients and carbon dioxide gradients existing above the corn crop.

The figure gives the percentage of the net radiation used by an active corn crop for photosynthesis on a clear day. It should be pointed out that net radiation is the radiant energy left for plant use after reflected and back radiation have been deducted. The major part of this net radiation is used for evaporating water and heating the air. Nonetheless, the photosynthesis process utilizes an appreciable percentage of the net radiation particularly in the early part of the day.

Three factors are believed to contribute to the particular shape of this efficiency curve. First and foremost, the photosynthetic mechanism evidently had maximum light for its operations early in the morning and late in the afternoon, so that additional light during midday hours went unutilized. Second, carbon dioxide was highest in the early morning and late afternoon and lowest during midday. Third, respiration was low in the morning. This latter point would explain why efficiency was higher in the early morning compared to late afternoon.

These facts give clues about how to increase the photosynthetic efficiency. Perhaps crops can be managed or bred to utilize more of the excess light during the midday period. The carbon dioxide supply to the crop also should be increased by creating greater wind turbulence. This should be possible with new management techniques. (III-B-3)



% NET RADIATION FOR PHOTOSYNTHESIS IN CORN ON A CLEAR DAY, ITHACA, N.Y.

Puerto Rico

CUTTING HEIGHT AFFECTS PRODUCTIVITY OF GRASSES

Ruben Caro, Rio Piedras.--The productivity of the five most important grasses of Puerto Rico was strongly affected by cutting height.

Heavily fertilized plots of Napier, Guinea, Para, Pangola, and molasses grass growing on Catalina clay at Orocovis, were harvested every 60 days over an 8-month

period at heights of 0 - 3 (low), and 7 - 10 (high) inches. Yields of forage obtained are summarized below:

Grass	Cutting height	Green forage per acre
		Pounds
Molasses grass..........................	High	65,500
	Low	32,700
Pangola grass..........................	High	62,200
	Low	98,900
Para grass..........................	High	75,200
	Low	101,200
Guinea grass..........................	High	89,600
	Low	95,800
Napier grass..........................	High	124,400
	Low	154,100

Para, Pangola, and Napier grasses produced much higher yields when cut close to the ground. On the other hand, yields of molasses grass were severely reduced by low cutting.

The marked difference in the response of the various grasses to cutting height is an important consideration in their management. (VI-A-1)

Texas

CONSERVATION FARMING WITH LIVESTOCK INCREASED PROFITS IN 1958

R. M. Smith and R. C. Henderson, Temple, and Ralph H. Rogers, College Station. --Beef cattle, grain sorghum, corn, and cotton yielded net profits, in that order, in diversified conservation farming on the 350-acre Blackland Experiment Station in 1958. Net income from cattle was $6, 319 and $4, 058 from all cash crops making a total of $10, 377. This is the highest net return obtained during the 4 years in which economic analyses have been made by Ralph H. Rogers, Agricultural Economist, Agricultural Research Service, College Station, Texas. Previous net profits were $5, 345 in 1955, $4, 165 in 1956, and $4, 813 in 1957.

The price situation in 1958 was favorable to a beef feedlot operation. Stocker calves that were purchased for $20 per cwt. in 1957 were marketed as good fat steers at $26. 50 per cwt. on December 16, 1958. Feedlot costs were about $0. 18 per pound of gain which made the operation very profitable. Even so, the profit was to some extent a result of the total steer grazing and feeding operation as well as the availability of homegrown grain and hay at farm prices.

Approximately 100 head of steers for marketing and 110 calves averaging 400 pounds per head at purchase on August 8 for feeding were handled during 1958. The calves are being wintered in preparation for the 1959 grazing and feeding season.

Grain sorghum grown on 74 acres yielded an average of 3,100 pounds per acre and netted $33 per acre. This was 23 percent of the total farm profits. Corn on 24 acres yielded 41 bushels per acre and netted $21 per acre, or 5 percent of the total farm profits. Cotton on 50 acres yielded 240 pounds of lint and netted $18 per acre, or 9 percent of the total profits.

Pasture crops that accounted for a total steer gain of 26,941 pounds were as follows: small grain with sweetclover, 103 acres--15,272 pounds or 57 percent of total grazing gains; grass pasture, 60 acres--7,127 pounds or 27 percent; and Sudangrass, 24 acres--4,542 pounds or 17 percent. In addition, considerable steer maintenance and some gains were obtained from grain stubble fields and other field residues.

Minor profits were obtained from oats and barley grain and oats for hay. Redtop cane hay was grown on other land and was charged to the cattle at market price of $20 per ton.

In this analysis all cash costs were included along with labor charges at $0.75 per hour, interest on investment in land, buildings, livestock, and equipment. The hours of labor and the amount and value of buildings and equipment were modified to reflect usual farm situations rather than the requirements of an experiment station.

This is the fourth successive year that a net profit has been realized from beef cattle in a diversified farming operation. It is recognized that specialization on expanded acreages is more popular with many farmers than diversification with livestock. Even so, there is strong evidence that the net return to management can be substantially increased by including a well-managed livestock enterprise in conservation farming.

Simplified systems which retain the basic advantages of livestock may appeal to many farmers more than complex systems. Pasture alone or pasture, grain, and hay can be used as the basis for successful conservation farming with beef cattle in this area without the complexities involved when cotton and several different grain and hay crops are grown. More attention to simple livestock systems in conservation farm planning appears to be justified as a means of attracting increased farmer interest. (VII-A-1, -2, -3 and VII-B-3)

HYDROLOGY--GENERAL

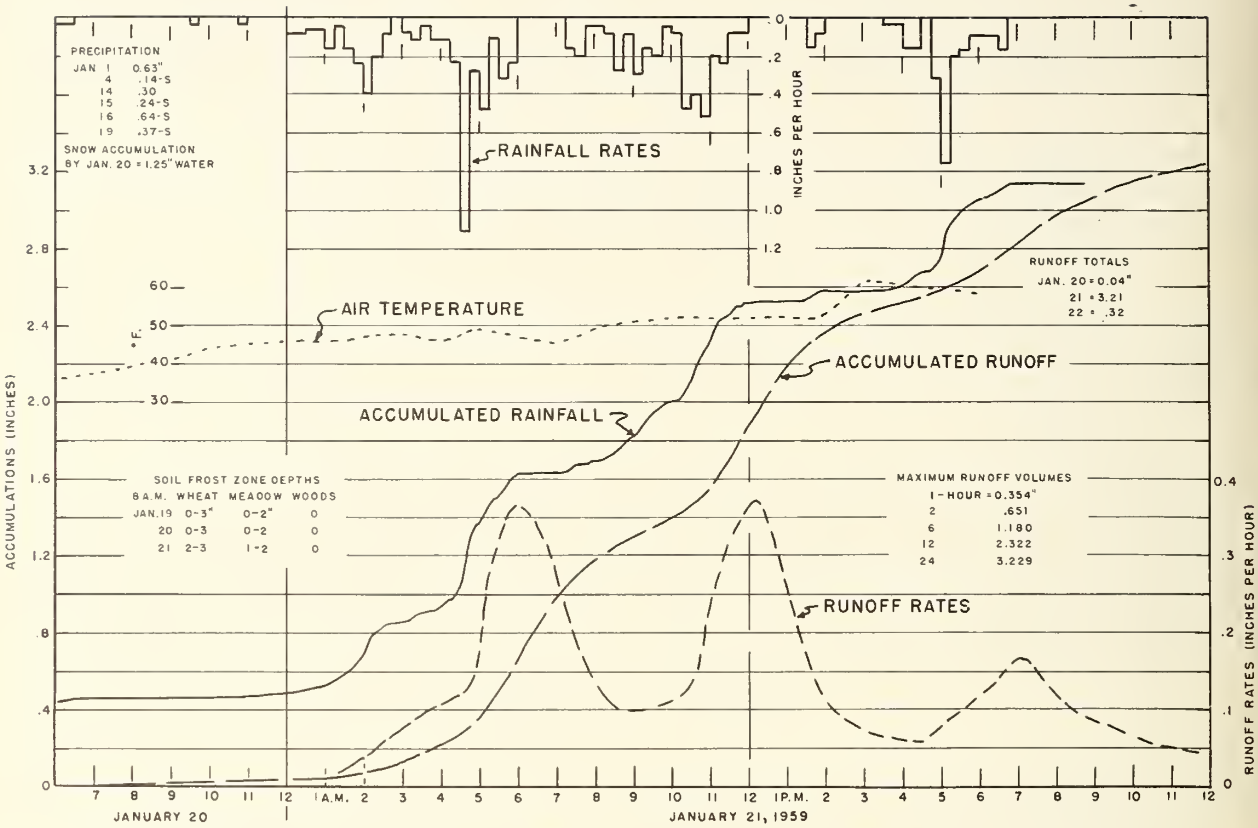
Ohio

JANUARY 1959 STORM CAUSED EXTENSIVE FLOODING

L. L. Harrold, Coshocton.--Flooding from the January 20-21 storm caused extensive damage all over Ohio and neighboring States. Five to six inches of rain in 30 hours along with snowmelt and frozen soil combined to produce a large amount of runoff and exceptionally high flood-peak rates. Reports of stream levels within 40 miles of the Research Station told of debris marks higher than those recorded for the disastrous 1913 flood. The Muskingum River was an exception. Storage of runoff water in the reservoir system of the Muskingum River Conservancy District effectively prevented flood damage in the highly developed valley area.

The hydrologic characteristics of the causative factors and the resultant runoff hydrograph for a 4,580-acre watershed on the Coshocton Station are presented in the figure. Total rainfall was 3.15 inches. Snow accumulation on the ground surface had a water equivalent of about 1.25 inches of water. All of this melted quickly when the air temperature on January 21 rose to 56° F. Soil in grass and wheat areas was frozen throughout most of the storm period. Total supply of water was 3.15 inches from rain and 1.25 inches from snow--equaling 4.40 inches. By the end of January 21, runoff had totaled 3.25 inches with another 0.32 inch observed on the 22nd.

The January 1959 peak on the 4,580-acre watershed of 0.373 inches per hour was the greatest peak observed to date during the winter season. The next highest previous winter peak was 0.206 inches per hour on February 25, 1956. The maximum annual peak of record, 0.724 inches per hour, occurred June 28, 1957. The January 21 peak was the second highest on record.



RAINFALL, RUNOFF, SNOW MELT, AND SOIL FROST FOR STORM OF JANUARY 20-21, 1959, WATERSHED 97, 4580 ACRES, COSHOCTON, OHIO

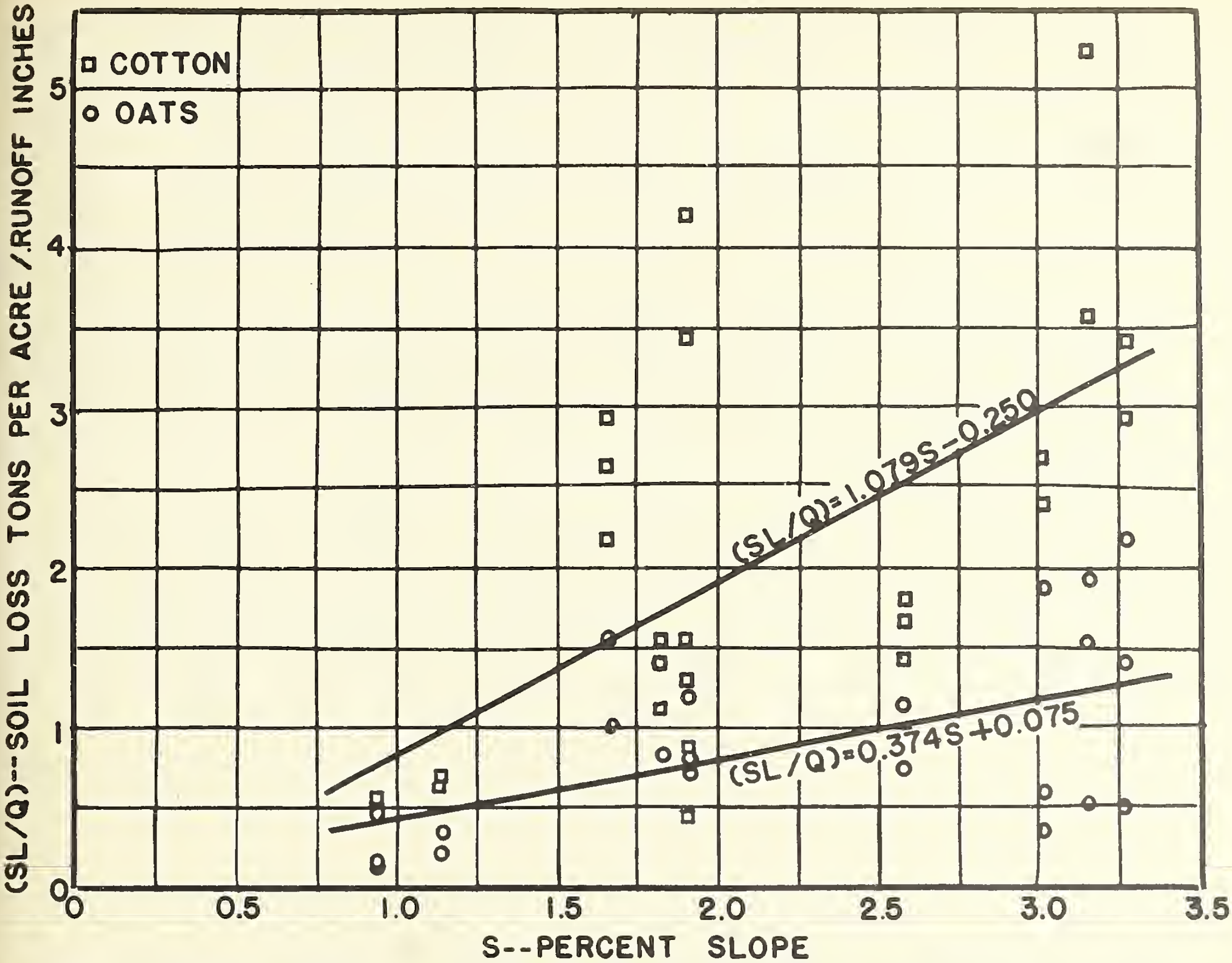
Total runoff of 3.25 inches is not all associated with the peak rate. As shown on the accompanying figure, the peak rate occurred at about 12:15 p. m. on January 21. Total runoff associated with this peak when separated from the total runoff period amounted to about 1.20 inches. (I-A-2)

Texas

RUNOFF DENSITIES VARY WITH WATERSHED SLOPE AND COVER

R. W. Baird and W. G. Knisel, Riesel. --Annual runoff densities, i.e., the ratio of annual soil loss in tons per acre to annual runoff in inches (SL/Q), for ten 3-acre watersheds at Riesel, Texas, were correlated with watershed slope by crops. The crops represented were cotton and oats with a single crop on a watershed each year. The watersheds were replicated by years from 1939 through 1943. The range of slopes of the watersheds is from 0.94 percent to 3.27 percent.

The runoff density ratios for cotton were considerably higher than for oats. Linear regression lines relating runoff density and percent slope (S) were computed by the least-squares method and the equations are shown on the chart. The small range of slope for these data does not justify an attempt to fit the anticipated curvilinear relation.



RELATIONSHIP OF ANNUAL RUNOFF DENSITY AND AVERAGE LAND SLOPE FOR 3-ACRE WATERSHEDS.

The correlation coefficients of 0.585 and 0.552 for cotton and oats, respectively, with 25 observations each were significant at the 1 percent level. The equations derived indicate that runoff density for cotton increases approximately three times as rapidly with watershed slope as does the ratio for oats. (I-B-2)

Mississippi

DEEP MOISTURE INSTALLATIONS MADE ON EXPERIMENTAL WATERSHEDS

J. R. McHenry and J. Kozachyn, Oxford.--A number of installations were completed for the measurement of soil moisture on a watershed basis by the neutron-scatter technique. Aluminum tubes, 2 inches in diameter and 10 feet in length, were installed as an access tube at each site. The holes were drilled with a portable power auger operating inside a two-inch steel casing. The casing was forced into the ground behind the auger. Upon completion of the drilling, the steel casing was removed and the aluminum access tube installed. Excellent contact between the soil and the access tube was obtained. Measurements of soil moisture will be made with the neutron apparatus and bulk densities will be measured using the gamma-ray-single-probe technique.

Changes in the soil moisture content will be followed to 10 feet on the watersheds. Losses of soil water to the atmosphere by evapotranspiration and to the ground water by percolation will be determined. Installations are completed on wooded, pastured, and idle lands and will be made in cultivated areas after planting. (I-B-6)

HYDROLOGY--LAND USE INFLUENCES

Texas

SURFACE SOIL AIRSPACE AFFECTS RUNOFF

M. A. Hartman and J. B. Pope, Riesel.--The February 14, 1959, storm produced runoff volumes which varied with surface soil conditions. Rainfall amount and intensity were very uniform, and the amount of moisture in the top three feet was very similar for all land uses, but the amount of runoff was significantly different by land uses as shown on the accompanying table.

Field observations preceding and following this storm indicated that there was a major difference in surface soil condition of the several watersheds. The effect of the surface soil condition on rainfall-runoff relationships has been noted and observed for many storms. It is usually described by such adjectives as loose, porous, spongy, firm, moderately compact, puddled, and many others. A quantitative index of the surface soil condition is needed to properly evaluate its effect on the rainfall-runoff relationship. The amount of air in the upper three inches of soil when the runoff-producing rain begins may be such a factor.

Volume weight and specific gravity were determined for the upper three inches of soil when field observations indicated that surface soil conditions were similar to those on February 14. The inches of airspace shown on the accompanying table were computed from these determinations.

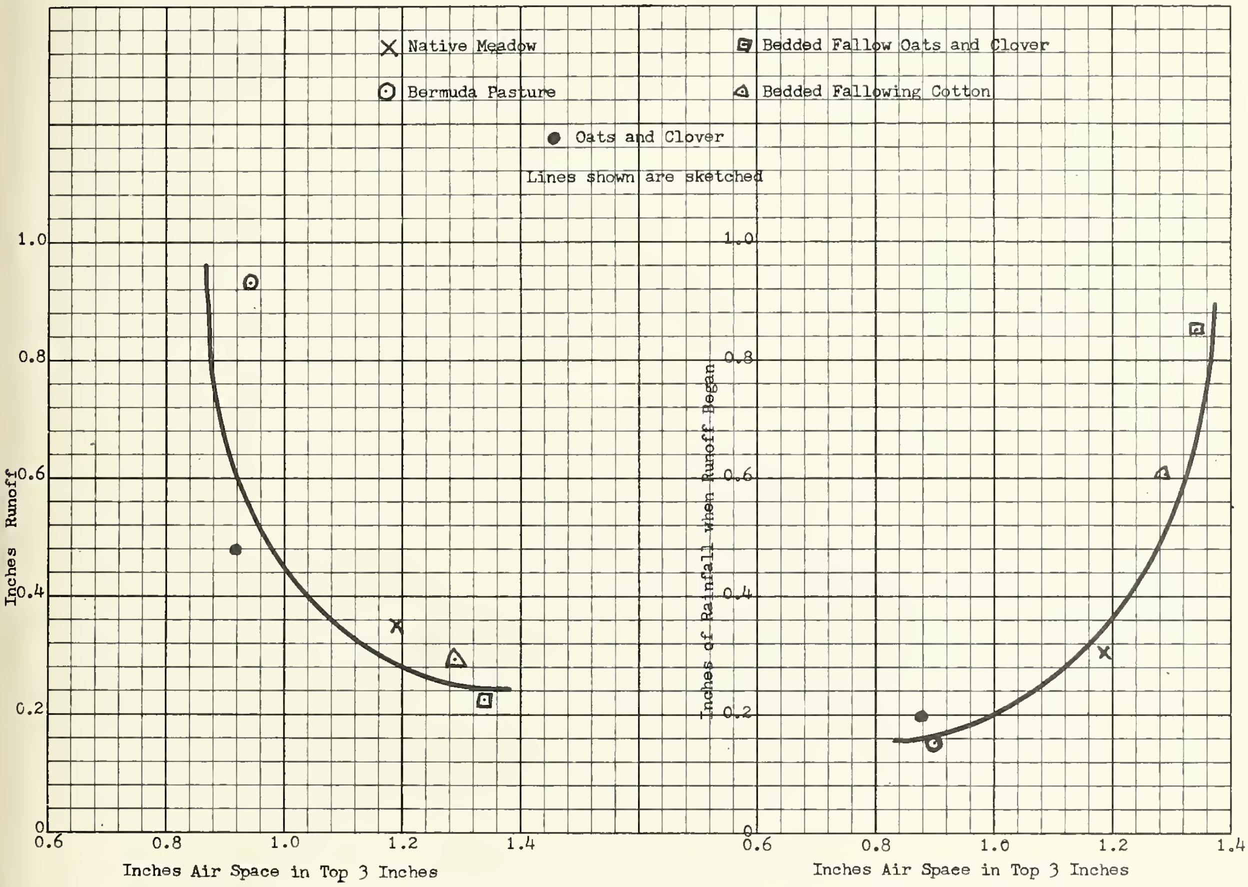
Precipitation, runoff, soil moisture, and soil airspace on watersheds under different covers for storm of February 14, 1959, Riesel, Tex.

Item	Watershed cover				
	Native meadow	Bermuda pasture	Oats-clover grain sorghum in 1958	Bedded	
				Oats-clover in 1958	Cotton in 1958
	Inches	*Inches*	*Inches*	*Inches*	*Inches*
Antecedent soil moisture above 18% in 3 feet....	6.43	6.63	6.40	6.44	6.99
Weighted precipitation...	1.47	1.58	1.42	1.55	1.46
Runoff..................	.35	.93	.48	.22	.29
Precipitation minus runoff.................	1.12	.65	.94	1.33	1.17
Precipitation before runoff began--estimated from charts............	.30	.15	.20	.85	.60
Airspace in upper 3 inches at beginning of storm.................	1.19	.94	.92	1.34	1.29

The chart indicates that for this storm the airspace in the upper three inches of soil had a major influence on runoff. Surface soil conditions must, therefore, be considered in estimating the rainfall-runoff relationship.

Further evidence of this is indicated by the relation between the airspace and the amount of rain before runoff began. This relationship is shown on the chart.

These two relationships of airspace and runoff and airspace and rainfall when runoff begins indicate that the airspace has a dual effect on the runoff. It not only affects the amount of rain that can be absorbed before runoff begins, but it also affects the amount that can be absorbed after runoff begins. (I-A-2)



Air space in top three inches of soil related to amounts of runoff and rainfall when runoff began for February 14, 1959, Riesel, Tex.

Mississippi

GAMMA RAY ATTENUATION STUDIED FOR SEDIMENT MEASUREMENTS

J. R. McHenry, Oxford. --Preliminary results indicate the attenuation of gamma rays is proportional to increasing sediment concentration in water. The following data are typical of those obtained when Cs-137 was employed as the source of gamma rays and the detection system consisted of a scintillation probe followed by a differential spectrometer:

Percent sediment	I_w/I_s*
0	1.000
.5	1.012
1.0	1.020
2.0	1.030
4.0	1.052
6.0	1.072
8.0	1.098
10.0	1.119
15.0	1.195
20.0	1.244
25.0	1.290
30.0	1.370

*I_w = activity density of gamma rays, water only (c. p. m.).
I_s = activity density of gamma rays, water + sediment (c. p. m.).
c. p. m. = counts per minute.

The data are reported for a 6-inch column of water. The attenuation of gamma rays in a 12-inch column of water follows the above relationship, but the absolute counting rate is, however, greatly reduced due to the shielding efficiency of water. The use of this technique to measure the sediment concentration in watershed silt boxes will necessitate stronger sources than are now being used. Variations of the technique which require the passage of the gamma rays through a lesser column of water are being investigated. (I-B-2)

HYDRAULICS

Oklahoma

TECHNIQUE DEVELOPED FOR TESTING TRASH GUARDS

W. O. Ree, Stillwater. --One of the first problems encountered in the model studies of trash guards was to develop a testing technique. The kind and amount of material to be used for trash, and a flow duration to provide a realistic test of a trash guard model were selected through experimenting with a model until it duplicated the behavior of a full-size structure.

A previously installed full-size drop inlet with a standard debris guard and anti-vortex baffle provided the prototype. Lovegrass hay was used in the full-scale tests. A 1/8-size model, of this drop inlet was built. Clearwater tests on the model showed it to duplicate the behavior of the prototype.

When dried lawngrass clippings were introduced into the flow to the model the similarity ended. The grass clippings did not act like the grass in the prototype. They floated on the water surface and did not accumulate on the guard racks. Even long duration pipe flows did not change this condition.

Other material was tried for trash. The one that gave the best result was hemp rope fibers. The fibers were cut to scale length, immersed for 3 minutes in a 6 percent sulphuric acid solution, washed, and dried. These fibers in the model were found to have action similar to hay in the prototype. They too would slowly waterlog, sink beneath the surface, drift toward the intake, and settle against the rack bars. The similarity of action is the important thing at this stage. With a little more experimenting to estimate the variance that might be expected in this kind of testing, the technique will be standardized and ready for routine application to proposed trash guard designs. (I-C-1)

Minnesota

TESTS OF TWO-WAY DROP INLET PLANNED

H. J. Johnson, C. A. Donnelly, and F. W. Blaisdell, Minneapolis.--Plans are being made for tests of a two-way inlet for closed conduit spillways. In order to expedite the studies, the width of the drop inlet is limited to one-pipe diameter, the height to five-pipe diameters, and the barrel entrance to square-edged. Drop inlet lengths from 2- to 10-pipe diameters will be tested. Various sizes and heights above the crest of the anti-vortex plate will be tried.

The problem will be attacked from two directions. Using water, the minimum size of anti-vortex plate to suppress vortex formation will be determined for various plate heights and plate skirt dimensions. Water will also be used to determine pressure coefficients for the crest and the anti-vortex plate and entrance loss coefficients for subsequent verification use. A model using air as the fluid will be used to determine, for full-flow conditions, the pressure coefficients and the entrance loss coefficients. Except for verification tests, all data will be obtained on the air model. It is anticipated that the air model will permit easier structural changes and the accumulation of more data in a shorter time than could be accomplished with a hydraulic model. (I-C-1)

Mississippi

MARCH STORM PRODUCES MIXED FLOWS IN PIGEON ROOST BASIN

H. B. Osborn, Oxford.--Data collected at the field gaging stations in the Pigeon Roost Creek watershed for the storm of March 26, 1959, are presented in the table. Rainfall, totaling 1.2 inches, was well distributed over the watershed occurring between 2 a.m. and 6:30 a.m. The streamflow stations of Pigeon Roost Creek have flat sand-bed channels and discontinuous rating curves. At a given gage height, one of two different discharges may pertain, depending upon the type of flow. Above a given average gage height, the flow usually shifts to the high-velocity curve with accompanying high discharge.

During the storm of March 26 several stations went to unusually high stages but adhered to the low-velocity rating curve.

At station 32 hand measurements indicated about 1,000 c.f.s. discharge at the peak. At this stage the low-velocity curve value is 500 c.f.s. and the high-velocity curve value is 1,700 c.f.s. There were apparently both high and low velocity flows in the channel at this stage. This opinion was substantiated by measured velocities which were higher in the shallow, hard-bottom side of the channel than they were in the deeper, sand-dune side.

Measurements at four gaging stations on the Pigeon Roost Creek (Miss.) watershed for the 1.2-inch storm of March 26 (a.m.), 1959

Item	Unit	Cuffawa Creek Tributary		Pigeon Roost Creek	
Gaging station.........		35	32	12	17
Drainage area..........	Sq. mi.	11.8	31.2	36.6	50.2
Time of peak...........	a.m.	7:15	8:00	8:15	9:00
Peak discharge (actual).	c.f.s	370	1,000	360	800
Gage ht. for peak......	Feet	4.44	6.35	5.20	9.36
Peak discharge .... (if on high curve)	c.f.s	700	1,700	735	1,400
Gage ht................ (for usual shift to high curve)	Feet	4.0	5.0	4.2	8.0

The time of travel for the peak from station 12 to station 17 was 45 minutes (3 miles). It is well under 30 minutes for high-range flow. (I-C-4)

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